WOOL SUBSTITUTES

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BY

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PREFACE

THE lower branches of the Woollen Industry are a direct outgrowth of economic practices in textile production. The basic idea of re-claiming the sound usable fibre from rags—new and old—and of making the resultant fibrous product into yarn and cloth, originated in the West Riding of Yorkshire.

Formerly, the factory operations and manufacturing equipment, to which this conception gave rise, were peculiar to the Heavy-Woollen districts of this country. Within the last three or four decades, the English system of manufacture has been exploited, but not superseded, in Continental and American textile centres.

An outstanding international asset, accruing from the production of goods made of "Wool Substitutes," is a commensurate supply of new clothing, at a reasonable cost, for the million.

To the ordinary and superficial observer, the Shoddy Industry is suggestive of manufacturing methods and processes in which spurious and adulterated materials are employed. It should, however, be understood that shoddy, of all sorts, is literally *wool filament*, though *fleece wool* is not definable as shoddy; and also that the whole scheme of mill work, connected with the manufacture of shoddy into a woven fabric, is penetrated through and through with initiative energy, constructive ability, and brain effort.

Progress in the art of manufacturing "Wool Substitutes," as in the art of manufacturing natural wool, is measured by the skill of the worker, the trained

capacity of the cloth originator, the inventive faculty of the machinist, the resourcefulness of the business economist, and the industrial foresight and enterprise of the mill owner.

In this analytical study of the subject, the various classes and grades of the recovered materials, and also of the by-products, applied in this section of the woollen industry, are dealt with. The practices in making the materials into spun yarns and new cloths are also reviewed, and some consideration is given to the machinery employed, and to the variety of fabrics produced.

Commercial expansion is based on efficiency in factory output. Mill equipment and organization enter largely into this factor. The latest types of machinery for recovering fibrous substances from rags, waste yarns, and other sources, and also the machinery employed in yarn preparation and weaving, are therefore illustrated and described.

Through the courtesy of my friend Joseph Auty, Esq., J.P., Batley, this section of the book is enhanced in interest by a series of factory views of the Sorting, Carding, and Spinning Departments of the firm of Messrs. Joseph Auty & Co., Ltd., of which he is the founder.

I also desire to acknowledge my indebtedness to Messrs. Sir Titus Salt, Bart., Sons & Co., Ltd., Saltaire, for samples of Mohair, Alpaca, Cashmere and Camel-hair Noils; to Messrs. Reuben Gaunt & Sons, Ltd., Farsley, for samples of Crossbred and Merino Noils; and to the following firms for photographic and other machine illustrations—

Messrs. Fitton & Sons, Dewsbury; Messrs. P. & C. Garnett, Ltd., Cleckheaton; Messrs. John Haigh & Sons, Ltd., Huddersfield; Messrs. F. Hattersley, Pickard & Co., Leeds; Messrs. Walker & Smith, Ltd., Batley;

and Messrs. Wm. Whiteley & Sons, Ltd., Lockwood. The specimens of carded material, of condensed slivers and spun yarns, photographically reproduced in Figs. 44 and 45A and 45B, have been supplied by Mr. Armitage, Carding Engineer at the mills of Messrs. Auty & Co., Ltd.

R. B.

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WOOL SUBSTITUTES

CHAPTER I

ARTIFICIAL WOOL PROBLEM

Artificial Wool and Silk—Artificial Wool Filament Production—Causes which detract from the Solution of the Problem—Structural Characteristics and Differentiations found in Wool—Filament Length and Filament Structure relative to Manufacturing Work—Woollen, Mungo and Shoddy Yarns—Fibre Formation and Worsted or Combed Yarns—Textural Brightness and Fibre Structure and Quality—Wearing Durability of Wool—Behaviour of Wool under Friction—Chemical Composition—Requisite Properties in Wool Substitutes.

WOOL Substitutes are not *artificial* but *natural* fibrous products. They comprise (1) the filament by-products, which accumulate in the process of cloth manufacture; and (2) the fibre recovered from "waste" yarns and fabrics, and from "waste" hosiery and felted goods. In this sense they differ from artificial silk derived from wood pulp; and producible, under special conditions, from cellulose nitrates by dissolving the nitrates in a prepared mixture of alcohol and ether. The viscose solution thus obtained, on being forced through minute orifices into water, becomes an insoluble compound having a threadlike form. Suitable numbers of these threads are reeled and twisted together in acquiring the artificial silk yarn of commerce.

The manufacture of this efficient substitute for cocoon silk is assisted by the homogeneous nature and formation of the silk fibril, which, as spun by the silkworm, possesses the three essentials of a weavable thread—continuity of length, evenness of diameter, and tensile

property.* Other varieties of fibre—plant, animal or mineral—do not exhibit these characteristics in a like degree as silk. Their staple length ranges from a fraction of an inch, in cotton and short-stapled wools, to several inches in long-stapled wools, alpaca, and mohair, while their filament units differ in structure and in diameter measurement.

To produce, for industrial purposes, a material as a substitute for such fibres, is a more subtle problem than that of producing a substitute for a natural filament thread. It involves something additional to the manufacture of a fibre having continuous length, and which may, by doubling, be made into a yarn of a definite thickness, namely, the production of a fibrous substance which would, by mechanical practice, be formable into a spun yarn.

The acquirement of a compound of a like chemical consistency as that of wool, is only part of the problem. Provided this should be discovered, and that it could be economically manufactured, the question of making a fibre of the correct physical structure and of the requisite diversified spinning and clothing properties would still remain unsolved. The success achieved in the production of artificial silk has, however, induced certain investigations for attaining this object. If, it has been suggested, the finest and most delicate of textile fibres is capable of being artificially produced, why not, as a result of research, discover a substitute which, by standardized practice, would be convertible into a fibrous material of the nature of wool?

In pursuance of this idea experiments have been made with a view of imparting to vegetable fibres, particularly of the jute category, some of the properties of fleece wool. Beginning with a spinnable material more or less of the tensile strength of wool, and of a

* *See* Chapter on "Silk" in *Dress, Blouse, and Costume Cloths*, by the same Publishers.

known value in yarn construction, there appeared to be the promise of a measure of success. But it has been found that, while such fibres may be chemically treated to vary their manufacturing utility and application, they retain, in the process, their structural character. The resultant material is therefore an artificial *vegetable* as distinct from an artificial *animal* wool.

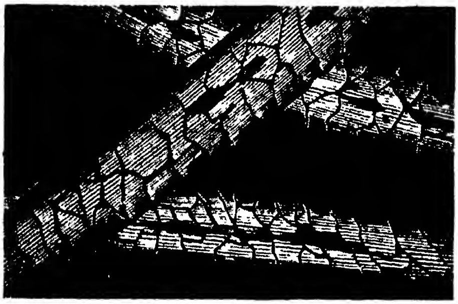

FIG. 1

MICROSCOPIC VIEW OF WOOL FIBRES

Another so-called artificial wool is claimed to be producible by separating the wool fibre or hair into its elemental parts. The process is one of filament disintegration for the recovery of the spindle-shaped cells. These constitute the body of the fibre, and may be defined as attenuated cell fibrils. Such fibrils average from 30 to 50 mm. in length, and are said to have been found convertible into a material applicable to yarn manufacture.

Waste wool is selected for the purpose. This, after cleansing and drying, is soaked in a weak acid bath in which a portion of the encrusted matter (i.e. the scaly sheath of the fibres, *see* Fig. 1) is carried off in solution.

The residual fibrils stick together, and their congealed state is only partially dissolved by washing and rinsing. The material is, therefore, further treated in an isolation solution composed of fatty acids or amides thereof.

The wool substance thus acquired is distinct from the wool substance recovered from rags by mechanical action. The latter operation leaves the filament structure unimpaired, and also a fair percentage of the filament length, whereas the chemical process removes the external scales of the fibre, and selects, for re-use, the corticle cells. It is possible that this material may have some practical application, but it cannot be regarded as an artificial fibre, inasmuch as it is only obtainable from animal wool or hair. Moreover, as will be elucidated, the mechanical systems of waste-filament recovery and re-utilization are so far perfected that the field for such a process of fibre disintegration is restricted, while the product acquired thereby is likely to prove of an indifferent technical value as compared with ordinary wool substitutes.

The problem of producing artificial wool would appear, on consideration of the real difficulties to be overcome, to be as remote from solution as the manufacture, on a utilitarian basis, of other common natural products, for the following reasons—

1. The substitute manufactured would require to be in a *filament* and not in a *threadlike* form.

2. The compound structure of the fibre (central part or medullary cells, cortical part or spindle-shaped cells, and the cuticle part or outer sheath of horny scales) does not lend itself to reconstructive science. (*See* Figs. 1 and 2.)

3. Wool differs in quality and application from natural causes and phenomena. Filament and staple are modified in character, and also in textural uses, with the breed of the sheep from which the wool is obtained,

by the climatic conditions under which the wool is grown, and by the pasturage on which the sheep mature.

Moreover, it is vital, as will be demonstrated, that a manufactured wool substitute should possess the structural characteristics and fibre differentiations existing in wool. These are fundamental in the raw materials usable in the woollen and worsted industries. All classes of woollen and worsted yarns—including yarns

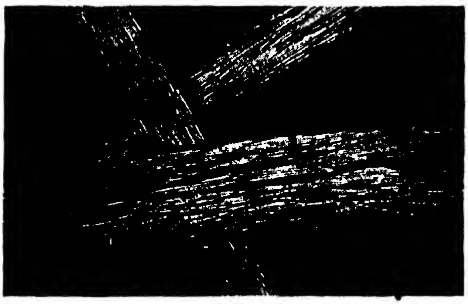

FIG. 2

MICROSCOPIC VIEW OF WOOL FIBRES, WITH OUTER SCALES REMOVED

made of "mungo," "shoddy," "waste," and "extract"—receive their distinctive properties from the filament units of which they are composed. A thread of a given diameter, with an average of twenty fibres has a different fabric value from a thread of a similar diameter and containing, in a cross section, a smaller average of fibres.

Degrees in filament fineness form an important source of the varied and composite results realized in woven manufactures. For certain descriptions of cloth—face-finished textures, Botany worsteds, and cashmeres—wools having a fine fibre are selected; for

tweeds, wools of a coarser fibre; and for lustre goods, wools of a regular external structure, and of a small or medium fineness of fibre, according to the quality of the fabric intended. Between the finest grown wools with an average fibre of $\frac{1}{2400}$ of an inch, and thick-haired wools with an average diameter of $\frac{1}{500}$ of an inch, there are numerous and complex gradations in fibre diameter. These gradations in filament fineness are favourable to the construction of the many classes of texture made of wool and other animal fibres.

Variations in length of filament constitute a further and equally effective source of industrial work. The wools of commerce are designated "short-," "medium-," and "long-staple"; but the fleece of any particular variety of wool is, for manufacturing purposes, classified into sorts or qualities according to filament length and fineness. From the shorter wools, several descriptions of woollen cloth are made; from the merino and even-grown wools, the better classes of botany worsted; from the medium-stapled Colonial and South American wools, crossbred serges; from medium wools of a less uniformity of staple—British and Colonial—tweeds and cloths of the Cheviot character; while from the longer English and Colonial wools, and also alpaca, mohair and cashmere, lustre goods are manufactured. Each average length of staple, as each average grade of filament diameter, with the range of differentiations of which they are susceptive, serve a purpose and have a place in textile productive practice.*

Assuming, for instance, a substance were discoverable answering to the variations in fibre length and fineness of wool, there is the insuperable difficulty defined of producing a fibre of a like structure. The order, grouping, and structural formation of the elemental parts of the wool fibre are responsible, in a large measure,

* *See* Chapter I, *Woollen and Worsted*, by the same Author.

for the felting, spinning, lustre and wearing properties which are known to distinguish wool from vegetable fibre. It is conceivable that a fibrous substance may be producible having one or several of these structural units, but the ratio in which they are found in wool would present a further problem for solution. It is the individual and the relative attributes of each element in the wool fibre, which give rise to the adaptability of wool for such a diversity of industrial applications.

Wool, on account of its disposition to felt, under suitable conditions as to moisture, heat and pressure, may be made into cloth without being spun. In this it is distinct from other descriptions of textile fibre. By separating fibre from fibre, and by reblending the fibrous units by mechanical means, layers or filmy sheets of wool are acquired, and a number of these are formed into a cloth-like material. The power which wool possesses to yield a coherent mass of filament of a prescribed thickness, exists, primarily, in the serrated structure of the fibre; and, secondly, in its wavy, elastic, flexible staple.

From wool, carded yarns—woollen, mungo, shoddy, etc.—are spinnable ranging from $\frac{1}{20}$th to $\frac{1}{100}$th part of an inch in diameter, and combed yarns—worsted—are spinnable from $\frac{1}{40}$th to $\frac{1}{200}$th part of an inch in diameter. This spinning range is attributable to the structure and tenuity of the wool fibre, which have an active and distinctive effect on the working of the material in the preparation of both carded and combed yarns. Thus, in making a woollen thread, the fibres, by reason of their structural character, may be mechanically separated and intercrossed in an illimitable number of ways, and with a minimum amount of surface bruising or dislocation of the surface scales. Moreover, as wool fibres are of a flexible nature, they may also be mechanically

mixed and united into a fleecy web of a uniform texture and density. In this condition, the outer scales of one filament link with the outer scales of another filament. Hence, the fleecy web is divisible into equal widths or strips—also without injury to the fibre structure—which, by frictional action, are rolled into soft, thick threads on condensed slivers; and such threads, after the insertion of a degree of twine, are draftable to a standard thickness. (*See* specimens A and B, Fig. 45.) During the process of elongation, the scaly portions of the fibre assist in preserving the filament relation developed. The addition of further twist (actual spinning), in which the fibres are rapidly twirled together, produces a yarn of a determined diameter and tensility.

In worsted thread preparation, other features and qualities of the fibre, also due to its structure, come into prominence. Up to the final stage in drawing and doubling the fibres are classified and arranged in parallel order, being, in the successive operations of combing and drawing, extended to their normal length, a routine of work which, in stretching them from root to tip, tests their elasticity strain. In these processes the filaments glide side by side, or receive a displacement in the lineal direction of the sliver. If the serrated surfaces of the fibres were not held, under such mechanical action, in a corresponding relation, they would lock with each other and impair or rupture the prepared "sliver" or "roving." In the whole scheme of combed yarn preparation, the length value of the wool filament is utilized to a fuller degree than in woollen-thread manufacture. The alignment of the fibres is sustained in the spinning operation, in which the serrated structure, as in woollen spinning, resists the otherwise disturbing and modifying effects of the forcible twisting of the fibres into a firm thread.

Brightness of textural surface in different makes of cloth—e.g. in the doeskin and fibrous-face costume, the Botany worsted and the lustre dress fabric—is a derivative of the external portion of the fibre, lustre being inherent in the cuticle scales encircling and covering the filament from end to end. In the more lustrous wools, and also in alpaca and mohair, these scales are of the larger dimensions, and by the use of such wools the brightest classes of texture are produced. But as the minute serrations in fine and wavy wools are also of a lustrous nature, they develop brightness of tone when such filaments, as in raised finished goods, are spread in regular serial order on the surface of the fabric.*

The wearing durability of wool is as proverbial as that of leather, and, perhaps, more so when its capacity for resuscitation in new fabric after new fabric is taken into account. This capacity is consistent with its composite structure. The flexibility and strength of wool are primarily due to the cells forming the corticle part of the fibre, and the wearing property and lustre quality to the external scales. The elongated cells run into thousands in each lineal inch of the fibre or hair, and, in the wear of a cloth made of wool, they singly and in combination sustain friction and strain. The outer scales are likewise numerous. They are firmly attached to, or embedded into, the shaft of the fibre, and increase in dimensions and in number with the growth of the wool. The specific functions of such scales are to act as a shield to the cell units of the filament, and to impart firmness of structure and surface lustre to the wool.

This complex organic structure of the wool fibre accounts for the filament undergoing degrees of alteration

* *See* "Lustre Fabrics" in *Union Textile Fabrication*, and "Face Cloths" in *Finishing of Textile Fabrics*, by the same Author.

in the processes of wear without actual disintegration. Some shortening and loss of fibre diameter takes place, but the structural formation of the fibre is only slightly affected. Rubbing a fabric made of wool develops a glaze on the surface when the threads employed in its construction are made on the combed principle, and may remove a small percentage of the fibre when the threads are made on the carded principle. But even after the cloths have been well worn, the fibres are found to possess, on dissecting the yarn, a fair percentage of their original weight. This is true of a portion of the fibres, though abstracted from threadbare fabrics or from mere shreds of cloth. They are distinctly reduced in circumference measurement, but retain some of the essential properties of new wool.

The chemical analysis of wool demonstrates its greater complexity as contrasted with cotton and silk. Thus, the wool molecule consists of 234 elementary atoms—C_{42} H_{157} N_5 SO_{15}—that of silk of 78 atoms—C_{24} H_{38} N_8 O_8—and that of the cotton molecule of 21 atoms—C_6 H_{10} O_5. Hence, whether the wool fibre is considered structurally or chemically, it constitutes a filament substance peculiarly inadaptive for construction by artificial means.

An efficient artificial wool, whether manufactured by chemical changes induced in other and cheaper fibres, or by the chemical and mechanical development of other products having corresponding chemical formulae, would need to afford, in textile production, the latitude and facilities which wool is known to provide. It would require to be a filament product which would present the range and variations in fibre structure, fibre length, and fibre fineness, as wool. This is essential. Cloth manufacture is extended, as shown, by the inherent properties which fleece wools, and also wool substitutes,

possess. Hence, an artificial wool, if producible, in order to be applicable to the woollen and worsted industries under this name, must correspond in some degree with animal wool or hair in spinning, tinting, shrinkage, lustre, and clothing essentials and values.

CHAPTER II

RECLAIMED OR RECOVERED WOOL

Uses and Application of Reclaimed Wool—Dimensions of the Shoddy Trade—Ratios of Consumption of Fleece Wool and of Recovered Wool Fibre—Wool Supplies inadequate to the Industrial requirements—Rag Imports—Shoddy Exports—Historic Data—Manufacturing Economics—Means devised for recovering Waste Filament—Rags the chief source of Re-manufactured Fibrous Materials—West Riding of Yorkshire Trade Organization—Classification of Regenerated Fibrous Materials.

ARTIFICIAL wool is plainly a problematical discovery, whereas reclaimed wools form a staple material of commerce. As pulled rags, or as "waste"—namely, the by-products of the processes of manufacture—they constitute the fibrous substances employed in the woollen factories of the Heavy Woollen districts of Yorkshire, and enter into the production of inferior classes of woollen goods in every important centre of the industry in the world.

Recovered animal fibre may be the only class of wool utilized, as in the union trade and in the manufacture of the cheaper grades of woollen fabrics; or it may be combined in varying proportions with new or "virgin" wool in the manufacture of fancy and more expensive goods. It should, however, be understood that the use of such wool substitutes does not necessarily imply the making of an indifferent variety of fabric. "Mungo" and "shoddy" cloths, in the systematized and skilled mill activities now practised, may possess the wearing and finished qualities, and tinted toning, of all-wool productions.

The several branches of the textile trade, in which these materials are used, are built up on economic lines. Their development has resulted in the better clothing

of the million. Whereas, before the invention of the rag-grinding machine, articles of clothing passed from one generation of wearers to another, since its use the cast-off clothes of the worker and his family have, within a reasonable period, been replaceable by new garments, and at a comparatively small cost.

Apart from the better and more economic clothing of the community which the introduction of wool substitutes has thus brought about, it has also removed the unhealthy custom of successive wearers, of different constitutional tendencies, being clothed in the same materials, and possibly more or less impregnated with the disease germs peculiar to each. All rags are thoroughly cleansed, and if need be, disinfected before being reduced to a fibrous condition. Further, the processes of reconstructing them into new cloths are of a purifying nature. The cleansing agents employed, as well as the whole system of yarn and cloth manufacture applied in converting the reclaimed material into a fresh fabric, eliminate all traces of infection with which the rags might, in the garments from which they have been drawn, be tainted.

The proportions of the industry, established in the employment of wool substitutes, are evident from the relative quantities of raw and reclaimed wool consumed annually in the manufacture of woollen and worsted goods. Great Britain and Ireland are credited with the yearly consumption of 350,000,000 lbs. of fleece wool; 230,000,000 lbs. of which enter the worsted industry, and the remainder—120,000,000 lbs.—the woollen industry. The latter also utilizes some 200,000,000 lbs. of pulled rags, and 30,000,000 lbs. of "noils" and by-products from the combing trade. From these figures it will be observed that about two-fifths of the total weight of wool fibre consumed in textile production in this country consist of wool

substitutes. These ratios of fleece and reclaimed wools are not peculiar to the industrial formation of the United Kingdom. America, Germany, France, Italy and Belguim, but especially the two former, are also users of large quantities of regenerated fibrous products.

Without the recovery of wool fibre from woven and other fabrics, the international woollen industry would, therefore, be to a considerable extent deprived of the raw material of manufacture. The world's wool supply is far from meeting the industrial requirements. This, for 1913, was estimated at 2,800,000,000 lbs., of which 1,074,000,000 lbs. were merino, 1,022,000,000 lbs. crossbred, and 700,000,000 lbs. were coarse wool. Some 63 per cent of the merinos was produced in the British Empire, 10 per cent in France, Russia and Italy, and 16 per cent in North America. On the other hand, of crossbred wool the British Empire produced only 10 per cent, whilst South America's share, mainly grown in the Argentine, was 32 per cent, and North America's 12 per cent. Of the low grades of wool, Russia accounted for 40 per cent and the British Empire for 9 per cent. Generally, the domestic wools of the United States and of most European countries are consumed in the home markets, so that practically the only wool-exporting centres are those of the British Empire and South America, that of the former being 68 per cent and that of the latter 32 per cent of the world's production in merinos and crossbred wools for 1916-17, with the proportions of 85 per cent and 15 per cent respectively in merino qualities. For the year 1913, 23 per cent of the British Empire's supply of merino wool and 65 per cent of the supply of crossbred wool were consumed in Great Britain and Ireland, against 33 per cent of the merino and 12 per cent of the crossbred being taken by Germany and Austria.

Analysing these statistics, it appears that about

FIG. 3

FACTORY VIEW OF RAG-SORTING ROOM

one-eighth of the world's supply in raw wool is consumed in British and Irish factories, to which has to be added the supply of materials classified as wool substitutes. The data are suggestive (1) of the extent of the commerce in the United Kingdom in textile goods made of new and reclaimed wool fibre ; and (2) of the growth of this commerce since the introduction of shoddy and mungo ; and due to the organization of economic practices in manufacturing which have led to the successful utilization of each class of fibrous by-product resulting, in regular or in irregular quantities, from the process of yarn making and fabric weaving and finishing.

If the annual supply of natural wool is viewed in relation to the 200,000,000 lbs. of recovered wool employed in woollen manufacturing in this country alone, it is evident that this section of the textile industry is dependent in its trading activities on the supply of rags from which such wool substitutes are obtained. During the years immediately preceding 1914, the imports of rags for mungo and shoddy production averaged between 80,000 and 100,000 cwts. per month. Recently these imports, owing to the abnormal trading conditions prevailing, have declined considerably, as shown in the returns for the months of June, July and August, 1920, and stated below—

	June.	*July.*	*August.*
	cwts.	*cwts.*	*cwts.*
From Germany . .	1,095	2,520	342
,, Holland . . .	4,828	2,814	2,431
,, Belgium . . .	3,836	1,076	2,406
,, France . . .	24,463	14,188	5,303
,, United States of America . .	5,063	3,089	4,927
,, Other Countries .	19,642	8,401	3,944
Totals . .	58,927	32,088	19,353

or the first eight months of the years 1913, 1919 and

1920, the imports were 740,000, 423,000, and 442,623 cwts. respectively. Much of the shoddy derived from these rags is exported, and the quantities dealt with under this head illustrate the extensive use in foreign countries of all classes of reclaimed fibre which the rags yield in the grinding operation. Some falling-off in the total weights of shoddy exported has occurred since 1913, but signs of recovery are becoming evident, the export of such pulled rags up to August 31st, for 1913, being 85,143 cwts., for 1919, 48,537 cwts., and for 1920, 66,634 cwts.

Considering the magnitude of this economic department of textile manufacture, it is hardly conceivable that it should have been practically an unknown industry a hundred years ago. Rag collecting and picking for paper making had, of course, been done, but in the sorting of rags for paper, those of a woolly nature were discarded. Certain makers of matresses and coverings for furniture, in London, were known to be users of flocks, but these were considered as unfit for woollen carding and spinning. About 1813, a Batley producer (Benjamin Law) had his attention, while doing business with a saddler in London, called to a fibrous wool substance. Enquiring as to how it was obtained, he learnt it was produced from stocking, hosiery, blanket and similar goods, and came to the conclusion that it was spinnable. Acquiring a quantity of these flocks and blending them with wool, he produced a class of manufacture which had a ready sale. Later, in 1834, Samuel Parr, of the same district, carried out experiments in rag pulling, and from the resultant material he made goods which were offered for sale at Ossett, near Wakefield. One buyer observing—"I daart it winnot goa," Parr replied "Winnot goa? It mun goa," and from this assertion the term which it now bears—"Mungo"—has been derived.

It is an axiom in the industry that every sort of wool fibre recoverable—that from a manufactured article or that from waste in manufacturing routine—is a valuable product. The principles of economic science are applied in every department of productive practice, with a view of utilizing in an efficient way all classes of reclaimed fibre. Should, for example, there be any proportion of fibre lost, or given off, in any of the operations in preparing yarn, or in the weaving of the fabric, or in the finishing processes, it becomes "waste" material which, when suitably worked and blended with other stock, enters into a further scheme of manufacture.

Means have been devised, both mechanical and chemical, for attaining these ends. Two methods of recovering such waste fibre, typical of the practices observed in each section of the shoddy industry, may be referred to. First, in pulling rags a small quantity of short, flossy filament drops on to the grids of the machine, with the dust and other particles of matter which have escaped from the rags. This by-product is put through a "dust shaker," where it is cleansed of impurities and converted into a material for mixing with other kinds of pulled waste. Second, in scouring, milling, washing-off and dyeing, a small portion of surface fibre, which has been removed from the cloth, escapes with the lye or solution. To recover this fibre, the solution is conveyed through a "separater," in which the loose filaments are gathered up by a slowly revolving cylinder, and rendered usable. Not only is the solution purified in this manner before passing into the drain, but a fibrous substance is collected in appreciable quantities.

One step in the recovery and re-utilization of waste fibre, though in the form of shoddy of the shortest description, has led to another; and, moreover, to the development and organization of practices which

obviate all real waste, or absolute loss of filament in the processes of manufacture.

Rags, however, constitute the main source of the material employed in the cheaper branches of the woollen industry. As a fibrous product, they take the place in the trade of wool in fancy manufacturing. They are obtained, as a result of a highly-organized system, from all parts of the world. The rag picker in any community collects the rags and disposes of them to local dealers, who roughly classifies them according to the materials of which they are composed. From the dealers they are purchased by the rag merchant, who re-sorts the rags into bulk qualities, in which condition they are offered for sale to the manufacturer.

The rags thus gleaned from universal sources are mainly consigned to the rag merchants in Dewsbury and Batley. To some extent, but not to the same degree as formerly, the rags of different countries have a special value, those of the United Kingdom being of a similar grade to those of America, France, Holland, Belgium, Germany and Italy, while those from Russia, Turkey, and the Far East, are of a more mixed variety, not so clean, but frequently bright in colour.

In the West Riding of Yorkshire there are numerous firms of rag merchants. Remarkable facilities have, as a consequence of their enterprise and business energy, been instituted for the collection, classification, and disposal of the rags in bulk quantities to the manufacturing community. Auction sales of rags are held periodically in Dewsbury, which, as regards the lower woollen industry, have a similar significance as the Wool Sales of London, Liverpool, Antwerp and Hamburg, dealing with the world's supply of rags as the Wool Sales deal with the world's supply in raw wool.

The trade in "waste" or "by-products" from manufacturing routine, is not so extensive as that in

shoddy, nor, with the exception of the "noils" from the combing industry, is it standardized on corresponding commercial lines. Each factory, as indicated, produces a definite amount of waste filament which is re-used in the factories in which it is made, but there is, in addition to this material, the fibre recovered from pulled yarns—spinning and weaving waste—which forms a considerable section of trade. The most important supply of by-products obtains in the "noils" resulting from worsted-yarn making. Next comes the supply from pulled waste, with a supplementary supply from the working of the machines in the mill, and also from waste known as "flocks."

There are, obviously, two general classes of wool substitutes—(*a*) the substitutes resulting from cast-off clothing and worn-out domestic fabrics described as rags, in which are included tailors' clippings, remnants and bits of new cloth; and (*b*) the substitutes resulting from the waste fibre made in manufacturing processes. The latter are known as soft material, not having been previously made into woven or knitted textures.

To produce any class of fabric the wool has to be sorted, scoured, blended, carded or combed, spun, woven and finished, and in each of these group operations some fibre escapes as a by-product. If the materials of manufacture should be of a shoddy class, there is a similar portion of unused fibre formed. For example, in carding, there are the "droppings" and "condensed sliver" waste; in spinning, pieces of slivers and threads made in piecening; in weaving, the "thrum" from the warp, and the weavers' waste in filling the shuttles and in picking up broken threads; and in finishing, the fibre or "flock" from scouring, raising, and cutting.

Reclaimed wools now comprise "shoddies," "mungos," "waste," "extract," "noils," and "flocks,"

and, as explained, may be classified into the materials obtained from rags and the materials obtained from the processes in either woollen or worsted yarn and fabric construction. They include—

1. Mungos, from old and new rags of a milled or firm structure.

2. Shoddies, from serges, Cheviots and flannels, scarves, stockings and knitted goods.

3. Extract, from woollen or worsted fabrics partially made of cotton.

4. Noils, a by-product in the operation of wool combing.

5. Waste from carding and spinning.

6. Waste from the warping, healding, and weaving processes.

7. Flocks from the processes of scouring, milling and cutting.

Every variety of mungo and shoddy, as well as each variety of by-product, will be separately examined, and the methods treated of in their application to textile manufacturing.

CHAPTER III

MUNGO AND SHODDY

Reclaimed Wool Fibre—Quality of Rag and Quality of Shoddy—Admixture of Rags made of different Sorts of Wool—Analysis of Shoddy Fibres—Miscroscopic Tests—Structural Variations in Shoddy Filaments—Shoddy and Woollen Goods—Operations in Mungo and Shoddy Production—Sorting—Bedding and Piling—Grinding or Pulling—Rag-grinding or Rag-picking Machinery—Suction Plant Conveyor—Effects of Inefficient Grinding.

SHODDY and mungo are the reclaimed filament substances, obtained from the pulling of rags and remnants of woven or knitted textures, in which the yarns are more or less closely interlaced with each other; or from bits and tatters of cloths, in which the yarns and fibres are compactly matted and felted together.

Thread dissection, for fibre composition, imposes the exercise of manipulative skill and nicety, but the rag-rinding machine separates the myriads of fibres entering ıto the woven, knitted, or felted structure, and produces herefrom an open, loose, fibrous material.

Extract is the wool substitute—treated of in Chapter V—due to chemical action, and is the material derived :om fabrics consisting of both plant and animal fibres. 'hus, by carbonizing, the vegetable matter is decomıosed, and the wool filament remains as the substance uitable for manufacturing purposes.

Mungo is a shorter class of fibre than shoddy, being cquired from milled or felted woollen fabrics made of short-stapled wool, while shoddy is obtained from ıbrics of a looser structure, either knitted or woven, nd composed of wool of a longer staple. Each material ı divisible into two categories, that acquired from new" and "worn" cloths respectively.

The quality and make of the texture, whether worn

or unworn, determines the quality of the *mungo* or *shoddy* obtained by rag grinding. Cloths of the beaver class, made of fine, short wools, yield a good, sound *mungo*; cloths of the tweed class, made of medium-staple wools, strong in the fibre, yield a springy or softly-handling *shoddy*. Or to take the khaki serge and the khaki flannel—two descriptions of fabric—they would give two varieties of shoddy, one of a full, flexible character, and the other of a softer and finer staple, but both of satisfactory spinning, milling and finishing properties.

With the admixture of rags of different wool constituents, the mungo or shoddy is necessarily of a still more varied quality. The variations in fineness and length of fibre, are largely neutralized by the promiscuous commingling of the several sorts in (1) rag grinding, and in (2) the subsequent blending of the fibres in the operation of yarn manufacture. There is, however, a distinct difference between the material got from the blending of "new" and the blending of "old" rags. On magnification, it will be shown that the structural composition of the fibres from rags, of whatever class of wool made, is somewhat deteriorated. The filaments, in the use of the fabric, are worn down. Waviness of fibre also perceptibly disappears, and the outer scales are either partially or completely removed in the process of wear.

Chemical analysis of shoddy does not exhibit any change in the fibres caused by wear, inasmuch as the substance of the shoddy filament is identical with the substance of the filament of fleece wool. But, with the magnifying of the fibres 100 to 150 diameters, the differentiations in length and diameter, due to friction and strain in the use of the cloth from which they have resulted, become evident.

In the first place, microscopic tests show that the

undyed fibres are either pure white or tinted yellow, according to whether the original wool has been a pure colour or not, or whether it has been modified by scouring or bleaching, or by the colours with which it has been blended. Whereas, in shoddies, from one shade of *new* rags there is a marked uniformity of tint, in shoddies of an approximate shade from *worn* rags, the fibres are multi-coloured, exemplifying the different systems of dyeing which have been followed. Samples of the latter have been found to consist of fibres dyed with indigo, with purpurine and with madder.

Another feature readily detected, by microscopic analysis, is the variation in filament diameters of shoddies resulting from each sort of old rags, and due to the amount of wear they have undergone. Fibres of this kind appear to contract gradually or suddenly in their lineal stretch, or they may be successively distended and attenuated in portions of their length. Moreover, in some low grade shoddies the scales are seen to be rubbed off with the fibres reduced to 0·01 mm. or less in diameter.

Mungo and shoddy filaments are more readily altered in structure by the action of strong potash or soda lye, or by strong sulphuric acid, than fibres of raw wool. Such solutions attack the fibres and strip away the external scales, leaving the elongated cells consisting of longitudinal striae or fissures. The fibres of wool or of shoddy which have not been impaired either in the use of the fabric or in pulling have the structural formation seen in Fig. 1. After treating with concentrated sulphuric acid, the outer scales having been decomposed, the fibres present the appearance seen in Fig. 2.

For observing the behaviour of the two substances microscopically, fibres of new wool and shoddy are placed side by side on an object glass, and a drop of

sulphuric acid of 66° Beaumé is put on the point of contact of the two fibres, and the time of attacking each fibre is noted when a glass slip is placed over the filaments, and observations taken of their structural alteration under a moderate magnifying power.

The shoddy fibres are the sooner changed and also to a greater extent than the wool fibres. The former, if dyed, almost invariably shed their colour, the effects of the discolouration slowly extending from the scales to the medullary canal, and proceeding until the whole fibre assumes a uniform tone. These effects coincide with the disappearance of the original structure of the wool, aiding the determination of the moment at which the scaly features are effaced. Should the fibres be undyed, and no discoloration occur, the exact instant of the decomposition of the scaly structure is also noticeable, because the alteration of the fibre is all the more apparent by the direct action of the acid on the wool. When the transformation of the shoddy fibre is complete, it is noted, and the time occupied gives the co-efficient for measuring the relative resistance of the fibres under examination.

Schlessinger's experiments, in this branch of textile research, yielded the data shown on p. 29 on shoddy and wool fibres of different coloured hues.

Micro-chemistry thus enables shoddy and new wool fibres to be identified. As a result of revealing the time in which the scales of the two descriptions of fibre become eradicated when treated with concentrated sulphuric acid, the experiments have also another value—they make it clear that, in the dyeing and finishing of shoddy manufactures, it is important, as far as practicable, to avoid the use of strong alkali solutions.

In view of legislative measures recently proposed in the United States for the control of the use of shoddy,

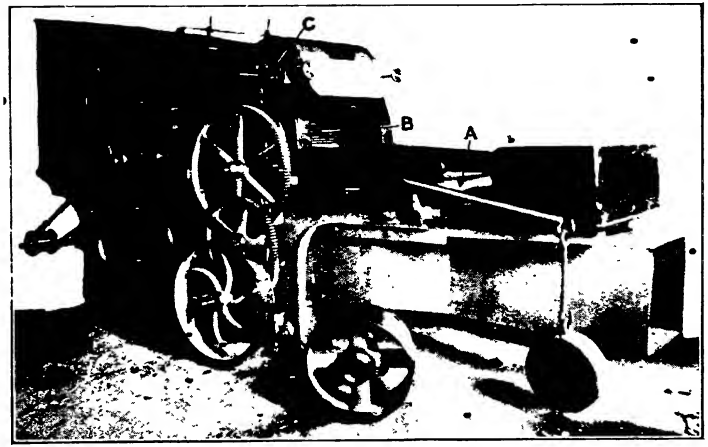

Fig. 4

RAG-GRINDING MACHINE

and of the attempts made in this country to restrict the use of the term *woollen* to goods made solely of wool, it should be noted that goods produced from shoddy are strictly wool products. They are in no

Colour Changes in Shoddy Fibres.	*Time occupied in the Decomposition of the Outer Scales of the Fibre.*			
	Shoddy.		*Wool.*	
	Mins.	*Secs.*	*Mins.*	*Secs.*
Green to yellow	3	45	4	05
Brown to light brown . . .	3	15	4	15
Violet to colourless . . .	3	15	2	55
Black to red	2	10	4	00
Red to pale red	1	45	6	05
Blue to colourless . . .	1	45	1	25
Yellow to dingy yellow . .	1	30	3	45
Pink to yellow	1	15	2	20
Black to yellow	1	05	5	10
Deep green to grey . . .	1	05	1	50
Deep yellow to pale yellow . .	1	00	1	45
Deep brown to orange . . .	1	00	1	15
Light green to colourless . .	0	45	1	30
Light grey to colourless . .	0	30	1	10
Colourless	0	15	4	30

sense adulterated or spurious woollen manufactures. The filament units in a shoddy fabric are as literally animal fibre as the filament units in fabrics composed of original fleece wool. The difference between the two classes of fabrics is confined to the shoddy, consisting of re-used fibre, and to the woollen, consisting of fleece or fresh-grown wool, or what the Americans define "virgin" wool.

Both manufactures being woollen goods, it is barely feasible, by analysis—chemical or microscopic—to discover the shoddy fibres when admixed with new wool, if the two sorts of fibre have been skilfully selected for, and blended together in yarn preparation.

The quality and tone of the clothes deteriorate with the increase in the percentage of shoddy, in consequence of the wool substitute being shorter in staple and less flexible in character than new wool. These distinctions between the two materials are evident on comparing raw wool with shoddy or mungo. The former is elastic to the touch, comparatively bright and clean in colour, with the filament and staple length unimpaired. The latter is perceptibly deficient in these properties, being less elastic, tender and short in the fibre, and dull and dead in colour.

Betwixt a Cheviot and a shoddy tweed, or a fine woollen and a mungo cloth, the differences in quality, handle, and in wearing strength are such as to be distinguished by the practitioner, and to be clearly apparent to the discerning consumer. The material factor—though wool in each class of goods, but new and re-used fibre respectively—imparts its nature to the woven and finished cloth.

The production of mungo and shoddy comprises rag sorting, blending and pulling. Women are employed in the sorting room, Fig. 3, which is well lighted and ventilated. The bales of rags, previously classified by the merchant (and with the quality and nature of which the manufacturer is fully acquainted), are picked in handfuls, which are spread on a sorting table having a wire-grid surface, through which some of the dusty matter passes. The operation is not particularly arduous but requires the exercise of judgment and discrimination in arriving at the "sorts" to which the rags belong. Handle or feel, as well as shade or colour, are the determining factors.

The number of sorts (about three) is fixed, and the sorter sets to work by clipping away the seamed bits, and by removing all pieces containing cotton or vegetable fibre, whether this be in the form of a thread or in the

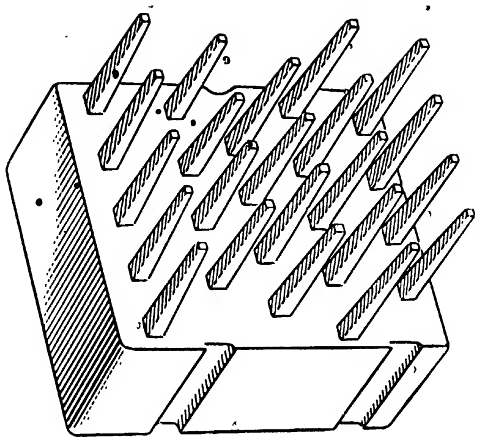

Fig. 5

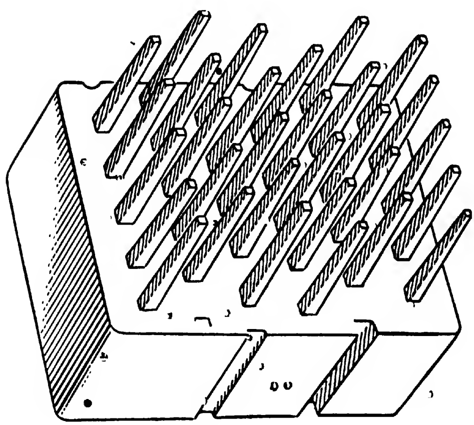

Fig. 5a

TYPES OF LAGS USED IN COVERING THE CYLINDER OF THE RAG-GRINDING MACHINE

form of a union yarn, that is, composed of cotton and wool. Cotton-adulterated fabrics are immediately detected; an experienced sorter perceiving at once by the handle of the rags if they contain vegetable matter. Such rags possess a firmer and closer feel than rags made of wool. The rags containing cotton, in any form, are grouped into a class to themselves, for carbonization.

Prior to "bedding," the rags may be run through a "shaker," a machine which softens their texture, and removes the dirt, dust, etc. It consists of feed and delivery travelling lattice sheets, usually both, placed in the front of the machine, and of a large spiked cylinder or drum (enclosed in the framework) making from 350 to 400 revolutions per minute. For carrying off the dust a powerful fan is employed.

During the operation, the rags are not only freed of hard dirty matter, but they are rendered more pliable and brought into a suitable condition for oiling, blending and piling.

In "bedding" the rags are distributed in layers and sprinkled with oil to facilitate and accelerate grinding, applying some five gallons of oil to each pack (240 lbs.) of rags. The "bed" or "pile" may consist of several cwts. or of three or more tons, varying, in the weight of the rags, with the character and composition of the "bed," and with the class of goods for which the material is intended. The pile is vertically divided, securing the same mixed assortment of the rags being placed on the feed sheet of the grinding machine, as exists in the layers of the rags forming the pile.

The machine used in pulling or grinding is that illustrated in Fig. 4, and is termed the "rag picker." The rags are placed on the feed table *A*, which carries them to the fluted rollers, set at a distance from the cylinder *B* to agree with the average length of the

rags being pulled. The "clothing" or covering of the cylinder is made up of lags studded with flat or round teeth, as shown in Figs. 5 and 5A. The lags have fifty-two teeth per row for hard goods, and twenty-eight teeth per row for soft goods, on a 36-inch diameter cylinder, having an 18-inch working space; and fifty-six teeth and thirty teeth per row for hard goods on a 24-inch diameter cylinder having a 20-inch working space. The average shoddy production in 10 hrs., on the machines with cylinders of these diameters, is stated below—

Diameter of Cylinder	*Mungo from New-cloth Clippings.*	*Mungo from Old Rags.*	*Shoddy from Merinos.*	*Shoddy from Berlins.*	*Flannels.*	*Shoddy from Knitted Goods.*
36″	7 cwts.	8 cwts.	7 cwts.	13 cwts.	7 cwts.	11–12 cwts
24″	6-7 ,,	7 ,,	6-8 ,,	11–12 ,,	6–7 ,,	10 ,,

Production depends on the nature of the rags, and on the working efficiency of the cylinder, the speed of which is regulated by the kind of rags being torn. Machines having a 36-inch cylinder are adapted for treating hard rags, and machines having a 24-inch cylinder for soft rags, stockings, hosiery goods, serges and flannels. The cylinder speeds (revs. per min.) for acquiring a maximum output—10 hrs.—on different materials are—

Diameter of Cylinder	*Mungo from New-cloth Clippings*	*Mungo from Old Rags.*	*Shoddy from Merinos.*	*Shoddy from Berlins*	*Flannels.*	*Shoddy from Knitted Goods.*
36″	750	500	350–400	300–500	300–500	300–500
24″	1,000	800	750	800	800	800

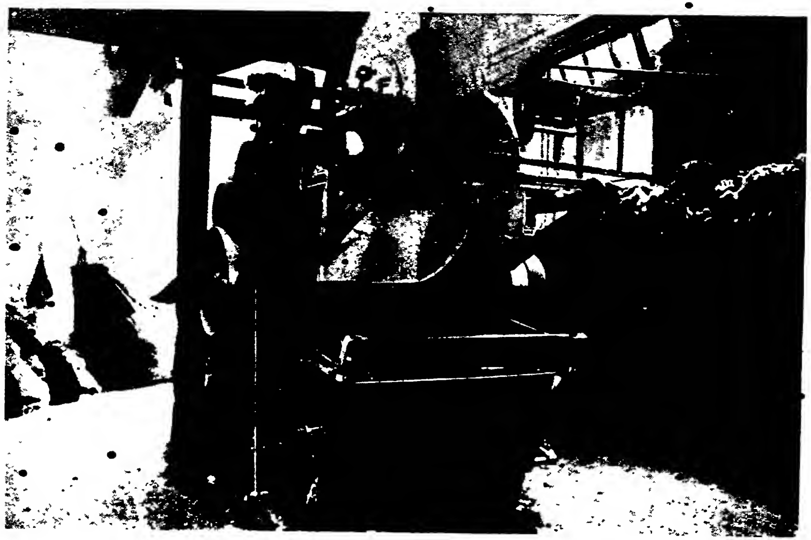

Fig. 6

FACTORY VIEW: BLENDING ROOM

The rags proceed from the feed sheet *A*, Fig. 4, to the fluted rollers, which grip them, when they are attacked by the teeth of the cylinder. The action of the teeth literally separates the fibres from each other in the individual threads of which the rags consist, and results in their being rapidly reduced to a fibrous, flossy substance or shoddy. Any bits of rag insufficiently torn come in contact with the blades of the "bitter" roller *C*, which automatically throws them back on to the feed table, to be repassed to the cylinder. The pulled material may be delivered by suction and conveyed by zinc piping into bales or sheets for reblending and carding, or it may be delivered from the front of the machine under the feed table. A fan is used for inducing a draught, and also for assisting the recovery of the shoddy in an even and open condition.

When the suction conveyor is used, it is that shown attached to the teazer in Fig. 6. In applying it to the rag grinder, the receiving end of the conveyor *T* is fixed underneath the machine. The fan *F* draws the treated material or shoddy into metal tubing, by which it is conveyed to another part of the mill or to any convenient destination. Thus, the plant may be designed to carry the shoddy from the "picker" to the blending or teazing room or to deliver it in sheets in the stock room. The system is economical and efficient and has advantages over the common practice of delivering the pulled material on the floor of the rag grinding department of the factory.

Ordinarily two types of machines are installed for the treatment of *soft* and *hard* cloths respectively, but a machine is constructed in which the cylinder may be changed according to the class of rag being dealt with. In using this type of machine, duplicate sets of feed rollers, driving pulleys and change wheels are necessary,

a set for *soft* rags, in which the feed rollers are larger in diameter, and a set for the *hard* variety of rags.

The resultant material, as compared with fleece wool, is deficient in staple or lock. The fibres in the shoddy are, however, in a freer and better separated relation than in wool, for, if examined, fibre can be readily picked from fibre, and the whole bulk product is equally lofty and open in texture. In raw or scoured wool, felted and entangled filaments occur in the staple, and the locks of the wool are also intermatted with each other, so that the wool, after scouring, requires to be mechanically worked before it is in so favourable a state for manufacturing as the material from pulled rags.

In one operation, rag grinding effects the reduction of odds and ends of cloths to a fibrous substance, and also the production of this substance in a condition suitable for carding, and this, though the filament constituents of shoddy may vary largely in length, fineness and character.

It should be understood that inefficient rag grinding is detrimental to carding, and to the preparation of a satisfactory yarn. Figs. 7 and 8 are microscopic views of two faulty pulled rags, the first on account of the matted or meshed groups of filament *A*, and the second on account of the cotton ends *A*, *A*[1]. The composite nature of the average blend of pulled rags is illustrated in the first specimen. The fibres are not only seen to differ in length and in fineness, but in their blended relation. They do not present any definite order, but cluster and criss-cross with each other in every imaginable direction.

The variable thickness, coarseness and length of fibres are very apparent in certain sections of the specimen, while the masses of the fibres are shorter and finer, and more freely mingle with each other. The former

A

Fig. 7

MICROSCOPIC VIEW OF MATERIAL DERIVED FROM PULLED RAGS

indicate that a certain percentage of the rags were of a different quality from the bulk of the rags torn up, but the differentiations in filament sort, in portions of Fig. 7, are fairly typical of the average shoddy. The shorter clustered fibre in Fig. 8 is more typical of the average mungo. Such marked differentiations in filament quality as here observed, are not, however, consistent with pulled rags representative of either a good mungo or a good shoddy.

The admixture of rags so different in fibre composition as here indicated, does not tend to yield a material which would card evenly and spin into a thread of equal fibre consistency through its length. The shorter fibres would have a tendency to run into the core of the thread, and the longer fibres to twirl round them, and unless, in carding and sliver production, each grade of fibre, long and short, were uniformly distributed throughout the material, the result would be an unsound and "twitty" yarn.

Moreover, the setting of the carding machines, for the effective distribution and intermixture of fibres thus differing in length, would be rendered difficult. The specimens are, therefore, illustrative of points to be obviated in the rag sorts passed through the pulling machine together, namely, rags substantially differing (1) in make and fineness; (2) in fibre character; and (3) in the facility with which the rags may be reduced to filament.

Rag-grinding machinery cannot be suitably adjusted for dealing satisfactorily with rags varying to the extent described. For producing either an evenly mixed shoddy or mungo, the rags dealt with must correspond in fabric quality and structure, by which is meant not only a similarity in the class of wool of which they are composed, but also in their adaptability to be torn up and converted into a fibrous substance simultaneously.

If, for example, the rags should be of the same grade of wool, but a portion of the fabrics comparatively loose in structure, and other portions of the fabrics of a firmer build, due to the weaving or milling practice, the setting and speed of the fluted rollers and the cylinder, while suitable for tearing up the former, would be less effective in tearing up the latter.

This feature emphasizes the importance of the work of sorting and of blending rags of a character which, in the grinding operation, will offer a similar quality of fabric, both as to fibre and as to make, to the action of the teeth of the cylinder. An ideal shoddy is one in which the fibres are of an approximate length and diameter, and in which they are so completely mixed as to make a material which, when opened out, shows the same nature and possesses the same handle throughout its composition.

The microscopic views of the "pulled" specimens in Figs. 7 and 8, suggest what takes place when, by any accident, or through lack of efficiency in sorting, bits of cotton are allowed to remain in the rags. The picker or grinding machine is not designed or constructed for the separation of fibres from each other in cotton or vegetable yarns, especially when these consist of isolated threads as in Fig. 8.

The thousands of teeth in the cylinder are equal to disintegrating woollen or worsted yarns. These they readily reduce to their fibrous units. But, while the cotton threads may be broken or torn on the surface, they remain more or less intact, and pass in this form on to the carding machine, where, if only fractions of such threads, they are liable to be carded with the wool filament and to enter into the sheet of carded material, and into the condensed sliver, in which case they would ultimately become part of the spun thread. Further, should cotton ends occur to any perceptible extent in

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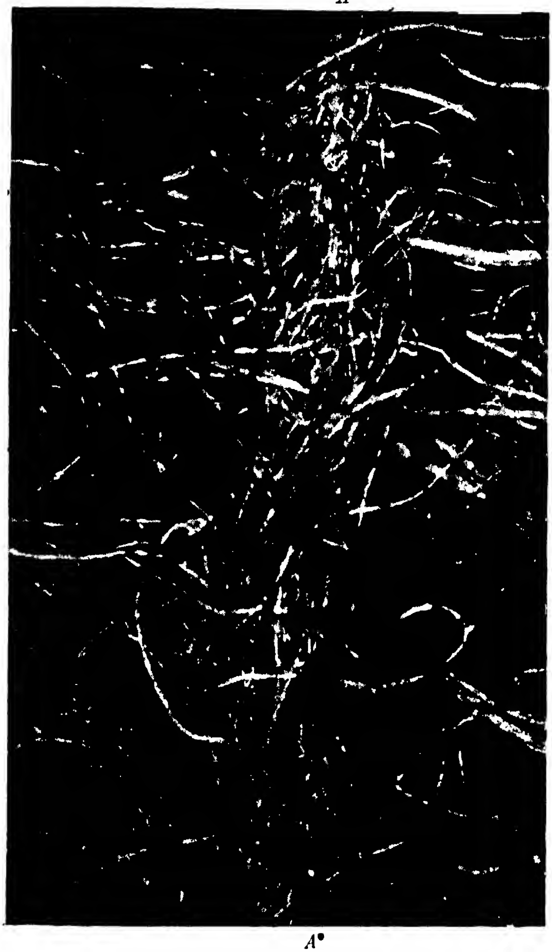


A

Fig. 8

MICROSCOPIC VIEW OF PULLED RAGS CONTAINING COTTON

the shoddy, they would form a substance that would, first, result in a defective yarn, and second, in a fabric which would be specked when piece-tyed. Both these microscopic views indicate the points to be obviated in rag-sorting and blending, as well as the general character of the shoddy, or recovered wool fibre, which results from the operation of rag grinding.

CHAPTER IV

EXTRACT WOOL

"Extract" the Material derived from Union Goods—Methods of Detecting Vegetable Fibre in Spun and Woven Manufactures—Chemical Reaction of Textile Fibres—Acid Tests—Microscopic Dissection—Forms of Application of Cotton in the Union Trade—Wet and Dry Processes of Carbonizing—Steeping Process, Routine of Treatment—Gaseous Process—Fitton's Carbonizing Machinery—Continental Practices—Rag Drying—The Hattersley-Pickard Hot-air Dryer—Whiteley's Enclosed Chamber Machine—Qualities and Uses of "Extract."

"EXTRACT" wool is a less valuable shoddy than that obtained from rags made solely of wool, being acquired, as previously stated, from carbonized cloths composed of both animal and vegetable fibres. As the chemical composition of cotton, wool, and silk differs, the fabrics in which they are used may be chemically treated with a view of destroying certain filament ingredients, and of leaving others intact. In producing "extract," the invariable object is the decomposition of the vegetable and the recovery of the animal fibre.

Seeing that, in fabric manufacture, it is a common practice to mix fibres of different structures and chemical affinities together, either for attaining a cheap product or a special textural result, the methods of detecting and separating each class of fibre, in the finished goods, require to be understood, especially as they suggest and illustrate the principles of carbonizing.

First, the chemical re-action to which the several descriptions of textile material are subjective may be noted—*Cotton* burns without smell: the fibre is unaffected by diluted alkalis, caustic or carbonated, but when suturated with diluted sulphuric or hydrochloric acid and dried, its structure is decomposed, and it is this basic factor which is utilized in the process of carbonizing

union goods. *Silk*, with all nitrogenous substances, gives off a pungent odour in the burning, and, like wool, is quickly dissolved by the use of diluted solutions of caustic alkalis. It is also destroyed by the action of concentrated sulphuric acid, while nitric acid solutions turn both wool and silk fibres yellow. *Wool* burns with

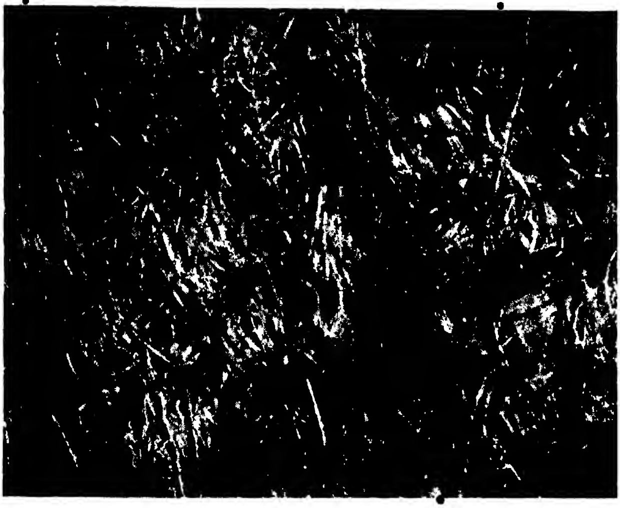


FIG. 9

MICROSCOPIC VIEW OF UNION CLOTH

the characteristic smell of horny substances; but the fibre is less affected by acids than cotton, and resists the action of sulphuric acid for some time if the solution is in a diluted and cold state. On the other hand, alkalis, particularly caustic, have a definite solvent action on wool, the fibre being totally dissolved in a solution of 1 per cent of its weight of $NaOH$.

Knowing the structure of the different classes of fibre,

they, as already seen, may be also detected and identified by microscopic examination.. A specimen of a flannel suiting, as seen magnified, is reproduced in Fig. 9. Approximately 70 per cent of the material in this fabric is wool, and the remainder cotton fibre. As

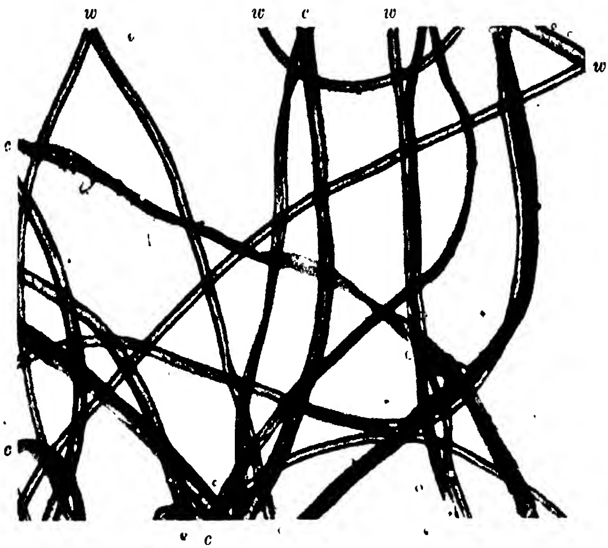


FIG. 10

MICROSCOPIC VIEW OF WOOL AND COTTON FILAMENTS IN DISSECTED UNION YARNS

viewed ordinarily, it has the appearance of an all-wool cloth, and to the inexpert would be regarded as such, for the traces of cotton in the handle are rendered almost imperceptible by the felting and raising practised in finishing the goods.

The microscopic test exhibits the structures of the two fibres, and also to some extent the qualities each

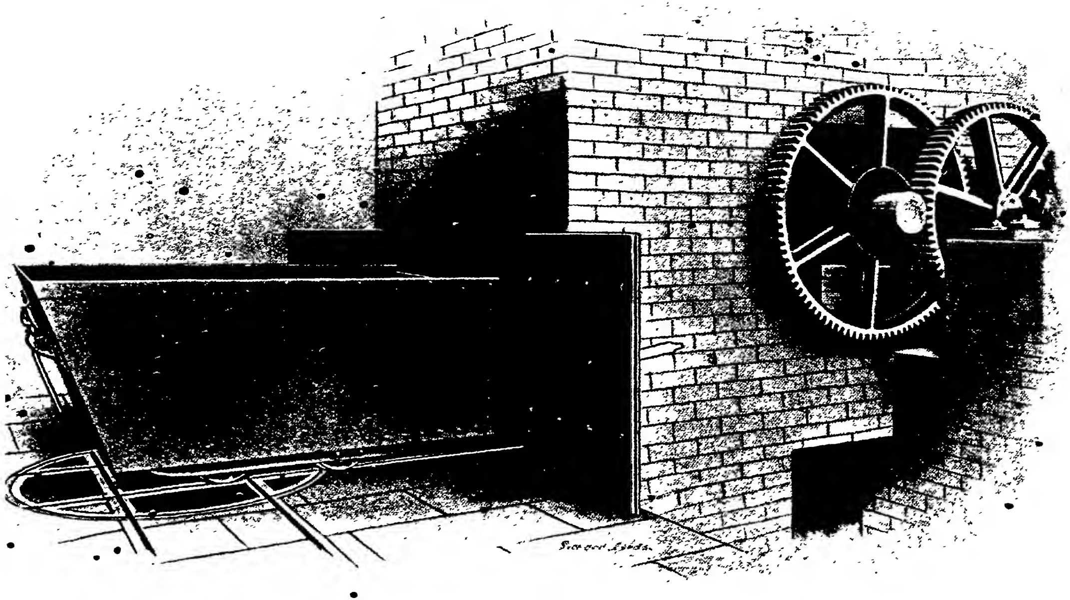


Fig. 11

FITTON'S CARBONIZING MACHINE, GENERAL VIEW

material imparts to the texture, as observed in the full dense character of the cloth in which the wool fibre is chiefly visible, and in the more filament-lined character where the cotton fibres are prominent. To form an idea of the relative quantities of the two fibres in the cloth, the yarns need to be dissected and the fibres microscopically examined as illustrated in Fig. 10, in which filaments *c* are undyed cotton, and filaments *w* undyed wool. The estimation of the respective fibrous units in a cross-section of the threads gives their numerical ratio but not their weight values. For the latter resultant, chemical analysis is necessary.

Cotton is applied in the manufacture of union woollens and worsteds on two distinctive systems, a knowledge of which is useful in sorting and grading the rags for "extract" wool. In the first instance, cotton is used in the form of a pure cotton yarn; and in the second instance as a bi-fibred yarn. Both these forms of application give rise to the presence of cotton in the manufactured goods in a number of ways.*

On the former system, cotton may be employed (1) in the warp, with woollen, worsted, mohair or alpaca in the weft, as in medium and heavy cloths and in light dress fabrics; (2) as the stitching or binding threads in compound structures in woollen and worsted cloths; (3) as a folded or twist yarn in gabardines, Venetians and fine twilled textures; and (4) as the striping yarn in piece-dye worsteds made in the grey and dyed in the piece to any selected shade, leaving the cotton striping ends untinted.

On the second system, cotton is used in yarn preparation in making carded and combed yarns, when the ratios of wool to cotton may vary from 10 per cent to 90 per cent in the spun product. It is also used in making bi-fibred worsted yarns on the French principle.

*See *Union Textile Fabrication*, by the same Author and Publishers.

In sorting and batching the rags for carbonizing, the manufacturing practice adopted in the production of the cloths from which they have been obtained is taken into account; for it is found that the results of the process are more satisfactory in the case of the rags from different types of cloth being classified into special lots and treated separately.

Two methods of carbonizing are practised in this country, that of treating the "union" rags in a sulphuric acid bath, and that of treating them in the dry state with hydrochloric acid gas fumes. The latter method is being increasingly followed.

Dealing with the first method, the routine generally adopted is as follows—

The sorted and graded rags, having been "shaked," "dusted" or cleansed, are immersed and soaked in a bath of sulphuric acid at 0·5° Bc., after which they may be hydro-extracted to remove any excess of acid solution. Hydro-extracting is preferable to passing the rags between squeezing rollers, as it leaves them in a free workable condition. They are now dried at a temperature of about 210° F., or drying may be performed by conveying the rags over steam cylinders at 260° to 300° F.; but when this is done, the rags have to be rapidly passed through the machine, or the wool fibres are rendered harsh and brittle. In a temperature of 210° to 230° the acid solution becomes concentrated, and its action on the vegetable substance is seen in turning it black, or a dark brownish hue, and in reducing it to a charred or carbon substance. The latent effects of the acid on the reclaimed wool fibre are then neutralized by rinsing the rags in an alkaline bath. The rinsing requires to be thoroughly done, and may be repeated, in some instances, in solutions of various salts such as alum, tin, sulphate of zinc or chloride of lime. The first rinsing should, however, be rendered efficient.

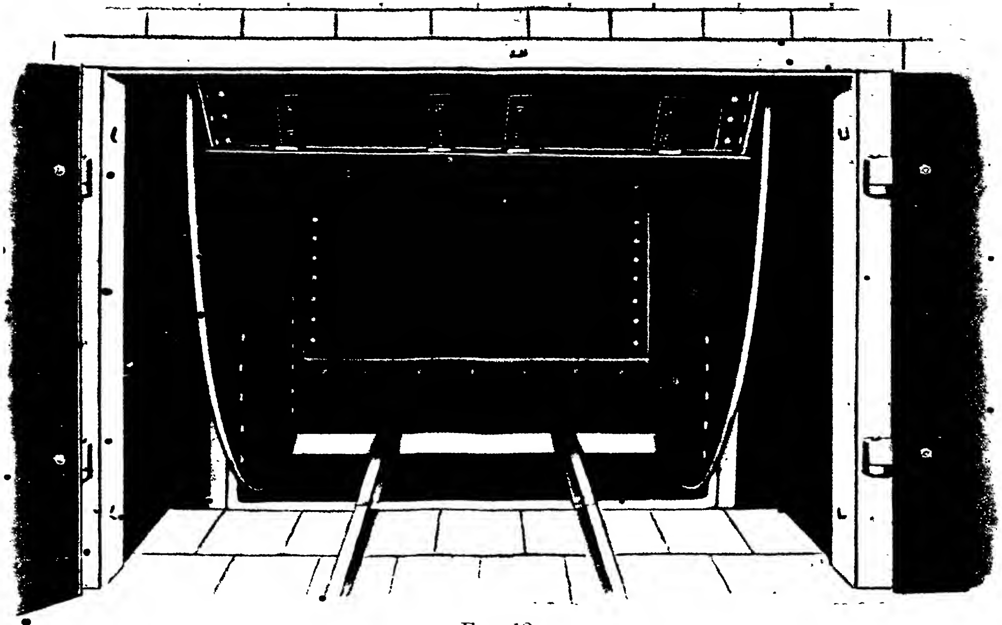


Fig. 12

FITTON'S CARBONIZER—WITHOUT TRUCK

as subsequent rinsings have a tendency to weaken the wool staple.

The hydrochloric acid gas process has one important factor in its favour besides that of convenience and simplicity—it enables the temperature in carbonizing to be lowered, which preserves the softness and lustre of the wool fibre recovered. It also provides for the rags being treated in the dry condition. The apparatus employed consists of a large drum or cylinder revolving in an enclosed chamber—Figs. 11 and 12—and of retorts, heated by tubes, in which the acid is generated. The gas liberated passes through the rags, and in so doing effects the carbonization of the cotton or vegetable fibres of which the rags are partially composed.

Fitton's invention for dealing with the rags in the bulk—a truck load of 500 to 700 lbs. weight at a time—is illustrated in Figs. 11 to 14. The rail and turn-table arrangement, on which the trucks run in their passage to and from the chamber, is shown in Fig. 11, and also the driving gear of the machine. Fig. 12 is a front view of the drum with the truck withdrawn; Fig. 13 a corresponding view with the truck clamped in a working position in the cylinder; while Fig. 14 is a sectional view of the drum when revolving and carrying the truck loaded with rags.

The apparatus, as devised and constructed, eliminates one of the most objectionable features in carbonizing, that of handling the rags in emptying and refilling the machine. In other practices this work may occupy from 20 to 30 mins., but in this improved system it does not require more than 2 or 3 mins. It is achieved by running the coach or truck of rags direct into the carbonizing chamber, when it is immediately clamped in position in the cylinder, the door of the chamber closed, and the machine set in motion. On the rags being thoroughly carbonized by the action of the gaseous

fumes, the drum is stopped in the position shown in Fig. 13, the truck removed and conveyed on rails to any convenient part of the works, and replaced by a truck of uncarbonized rags.

Amongst the salient advantages of this practice, the following may be noted—

1. A great reduction—amounting, it is claimed, to 90 per cent—of labour and time in charging and emptying the machine, with a consequent benefit to those unemployed in the operation.

2. An estimated increased output of 30 to 50 per cent, as compared with other types of machinery of the same dimensions.

3. The prevention of the rolling and lapping of the rags, which accelerates and ensures the destruction of all vegetable matter they contain.

4. As a result of experimental tests in the carbonizing of dark rags, it has been found that the original colour of the materials is only affected to a small degree in this operation.

The whole routine is automatically carried out, and with a minimum amount of manual labour such as that involved in the ordinary practice in handling the rags when charging the machines.

In addition to the machinery shown, each carbonizing chamber is fitted with a furnace, a metal retort, and an acid tank. The hydrochloric acid is supplied in the fixed quantities when the apparatus is in operation, to the surface of fire bricks placed in the retort. The gas thereby generated is conveyed into the interior of the truck load of rags. At the same time the heat from the furnace raises the temperature to 212° or 220° F., during which carbonizing takes place. The gas fumes escaping from the chamber, after "scrubbing," are conveyed to the chimney stack of the works.

Following the process, the rags are run through a

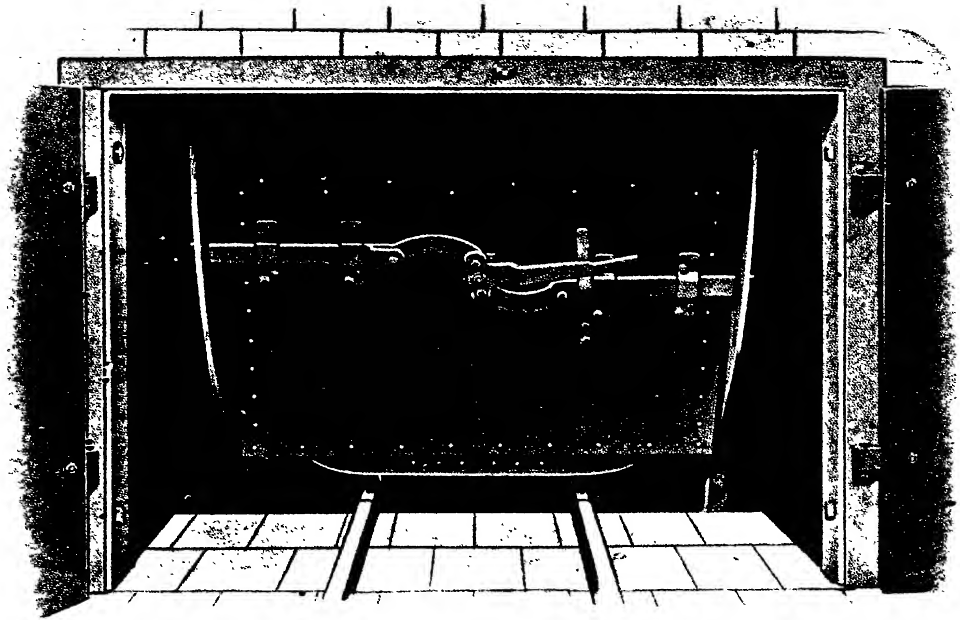


Fig. 13
FITTON'S CARBONIZER. CYLINDER MOUNTED WITH TRUCK

"wincey," a centrifugal machine for shaking out the dust from the rags, which are removed from the interior of the machine by the action of a revolving fan. They are then taken to the shaker, when they are ready for grinding.

All varieties of woven, knitted, and other goods are dealt with, such as those made of angola yarns, and of admixed cotton and wool yarns. An examination of each sort of rag before and after treatment proves the efficiency of the system, which is seen in the total extraction of the vegetable matter, in the recovery of the whole of the animal fibre in the rags, and in the production of a good quality of shoddy or mungo.

In the case of knitted and woven textures made of yarn composed of wool and cotton, the wool fibre is left in a threadlike form; or, if the percentage of cotton should be greater than that of wool, it remains in a loose fibrous state. In the case of rags in which cotton threads occur, as, for example, in Bedford cord cloths in which there are cotton threads between the stripings, these, after treatment, are found to be completely carbonized, with the fine woollen thread stripings in the serial order in which they appeared in the original rags.

Another feature of the system is the colour tone of the rags dealt with. In some instances it is brighter and clearer than in the rags prior to carbonizing. This is particularly noticed in materials of a red, blue, brown or green tint, all of which colours are, in a degree, revived or freshened by this method of cotton extraction.

Other methods of carbonizing by means of acid generated gases, and adopted in France and Belgium, are those of Rottier and Sirtain. Rottier's process includes the exposure of the rags to the action of hydrochloric acid gas without damping, and then of subsequently passing them over heated frames; or the rags may be placed in an oven or conveyed over drying cylinders

heated to the required temperature, neutralization being carried out in the ordinary way. Sirtain's process differs in details and in the method of neutralizing. It includes the passing of the rags through (1) a chamber charged with hydrochloric acid gas; (2) a hot-air heated chamber for actual carbonizing; and (3) an ammoniated vapour chamber for neutralizing purposes.

Rag drying, after the wet process of carbonization, is performed on machinery of the "table" or of the "continuous feed and delivery" construction, as well as on the Fitton system, when the enclosed chamber is heated by hot-air. Such machines are also employed for drying wool and other materials, following scouring dyeing, etc.

The primary object in the drying of all varieties of textile materials is to remove the liquid or excess moisture without injury to the original properties of the fibre. An advantage in natural drying is the evenness with which it is performed, the currents of air passing through and through the material constantly. It is essential that this object should, as far as possible, be attained in drying with artificially-heated air. With an uneven pressure and distribution of the hot-air currents, portions of the goods dried are liable to be scorched, others to be "bone" dried, and others to be partially dried. The absorptive efficiency of heated air is maintained so long as the air is renewed or increased in temperature. For satisfactory rag drying, these changes in the air currents should be continuous. This is accomplished in the Hattersley-Pickard drying apparatus illustrated in Fig. 15. It comprises a sectional air-heater *H*, combined with a screw-bladed fan *F*, and a drying table *T*, all of which may be duplicated, or the table extended to any required dimensions. The fan conveys the hot air through the heater, and

Fig. 14

FITTON'S CARBONIZER SHOWING CYLINDER AND TRUCK IN WORKING POSITION

forces it through the rags placed on the wire net covering of the table. High or low pressure steam, or exhaust steam may be used in sections S^1, S^2, S^3 and S^4 of the heater, or high pressure steam may be employed in certain sections, and exhaust or low pressure steam in other sections, by providing each section with separate inlet and outlet valves and drain pipes.

The temperature of the air currents having been determined, and the fan-shaft—engine or motor-driven—set in motion, the rags to be dried are evenly spread on the table, when the heated air draughts pass regularly through the rags, and induce a constant evaporation of the moisture they contain, until the rags are in the required dry condition. The temperature of the air may be readily regulated, as well as the pressure of the air draughts, the former by the inlet and outlet valves which may be independently adjusted, and the latter by altering the speed of the fan.

The employment of this machine enables from one to three tons of rags—standard dried—to be treated in a working day. The power for driving is from 3 to 4 H.P., varying with the size of the fan, and of the heating apparatus, and also with the condition and weight of rags dried at one time.

In Whiteley's and other makers, enclosed chamber automatic dryers the rags from the steeping tank are first hydro-extracted, and then placed on the travelling lattice feed of the machine. From the delivery rollers of the "feed" they are conveyed to a pair of top rollers, which deliver the rags on to an upper sheet by which they are passed to the further end of the chamber and dropped on to a lower moving sheet, to be re-passed, at a regulated speed, to the front part of the chamber. This routine is repeated on two or more lower conveyers, when the dried rags are removed from the machine by

positively-driven rollers. In practising this method of drying, what is termed the "baking" temperature varies from 180° to 230° F., according to the strength of the acid solution in the "pickling" or steeping process, and the rapidity with which the process is carried out.

After drying, on each system, the carbonized material is run through a crushing or shaking machine to remove the charred matter, when they are ready for the neutralizing bath.

Extract wool is obtainable in similar mixture shades and qualities, as shoddy and mungo from woollen rags. While it has not the felting property of the latter, it dyes satisfactorily, and is extensively used either as the staple material of manufacture, or in blending with other classes of wool substitutes, in the production of lightly-milled goods.

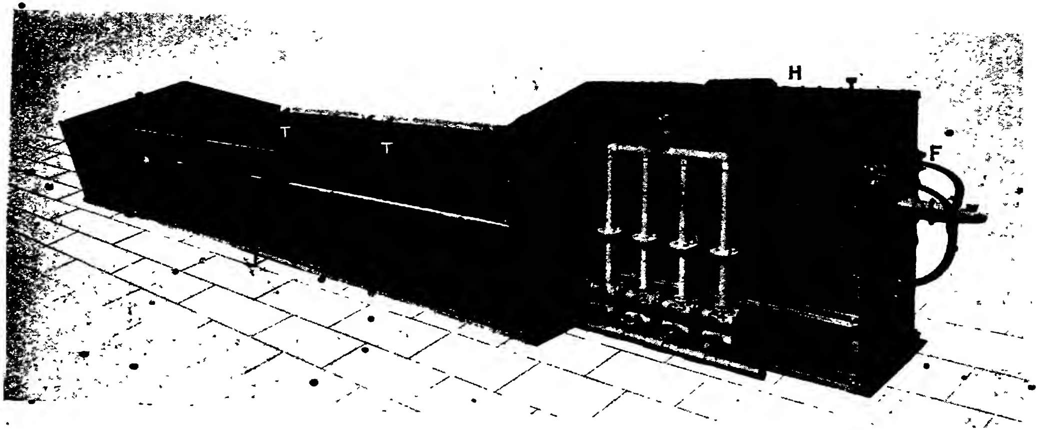


Fig. 15

HATTERSLEY-PICKARD TABLE DRYING MACHINE

CHAPTER V

NOILS—PULLED-YARN MATERIALS—FLOCKS

Noils a By-product of Worsted Combing—Character and Qualities of the Material—Merino and Crossbred Noils—Lustre Wool Noils—Alpaca, Mohair, Cashmere and Camelhair Noils—Uses of Noils in Woollen Manufacturing—Process Wastes—Carding, Spinning, Warping and Weaving Wastes—Pulled Yarns—Sorts and Applications of the Fibrous Resultant—Garnetting—Knotbreaker or Preparer—Single, Double, and Three-Swift Garnett Machines—Diameters and Speeds of Rollers in Garnett Machinery—Garnett Wire—Types of Garnett Wire and Applications—Weight of Wire for Different Rollers—Operation of Setting Garnett Wire—Milling, Raising, and Cutting Flocks—Employment of Flocks in the Finishing of Woollen and Mungo Goods.

Noils

In the process of combing, on both the English and the Continental systems, the "prepared," "gilled" or "carded" slubbings are divided into "top" and "noil."

The "top" slivers are the combed product, and consist of the longer and straightened fibres. They are used in the operations of drawing for making the roving which gives, in spinning, the worsted yarn. The "noil" consists of the short, curly, neppy fibre extracted, by the noiling parts in the comb, as unsuitable for the production of the level sliver essential in forming yarns of the worsted structure. "Noils" and "tops" are therefore both composed of the same variety of fibre.

English top-making is done on two types of machine—the Noble and the Holden—for merino and crossbred wools, and on a third type of machine—the Lister—for long-stapled wools, alpaca, mohair, camelhair

and cashmère; and Continental top-making is done on the Heilman machine, a construction of comb adapted for the treatment of the shortest growths of wool usable in worsted spinning. The staple of the material, rather than the principle of combing, determines the sort and quality of the noil. Hence, in the trade, noils are designated as Botany, Crossbred, Lustre, Mohair, etc., denoting that they are the extracted products from the combing of these materials.

Botony or Merino noils are fine in the fibre, of excellent spinning and clothing properties, and are applied in the woollen industry, in combination with wools of a similar length and fineness in the manufacture of Saxony yarns from 18 to 36 or 40 yards per dram. With the shortness of the merino wool staple employed in combing—average 1½ in. to 2½ in. in the English practice, and from ¾ in. to 1½ in. in the French practice—the fibre in the noils is proportionately reduced. In Crossbred noils, the fibres are longer but freer or less nappy in character. From the better qualities of Crossbred wools, the noils obtained are useful in producing woollen suitings and costumes; from the medium varieties, the noils are applied in producing Cheviots; and from the lower sorts, the noils are used in the manufacture of the coarser grades of Cheviots and also of blankets and rugs.

The neppiness which distinguishes the shorter and finer noils offers some difficulty in carding. To satisfactorily separate and straighten the fibres clustered and meshed with each other, the scribbling and carding require to be thoroughly done, otherwise neppy portions of fibre pass into the condensed sliver and get into the spun yarn, rendering the latter twitty and uneven.

Lustre noils consist of comparatively straight, long fibres, of a smooth and bright surface. They are used with the noils from medium-stapled wools in the tweed

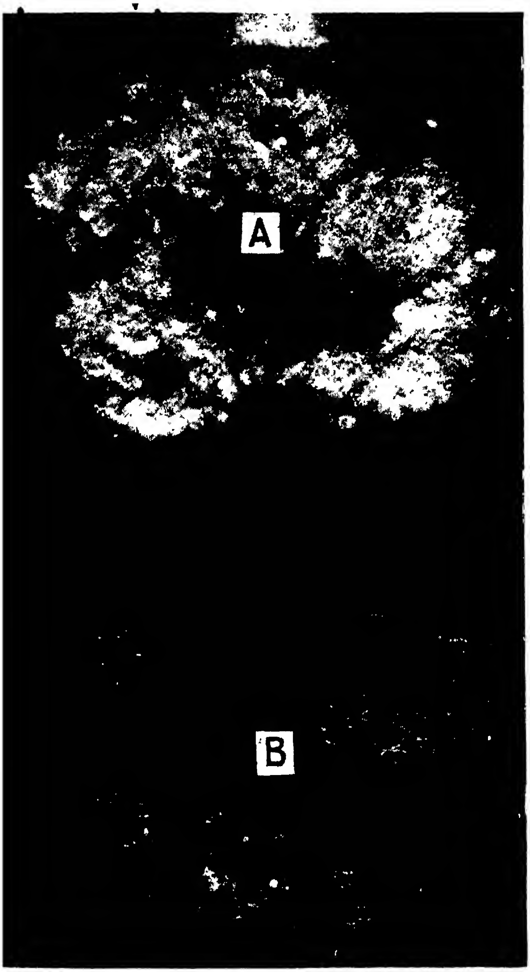


Fig. 16

SPECIMEN A: MERINO NOILS
SPECIMEN B: CROSSBRED NOILS

industry, and also in the preparation of carpet yarns by carding, drawing and spinning. In the different classes of goods in which lustre is esteemed, and also in the production of yarns of a moderate thickness—such as are used in making furniture and decorative plushes—these noils are largely employed. Mohair noils have a similar general character as lustre noils, but are brighter and cleaner in colour. They have also a special shrinkage value. Thus, when blended with wools of a Cheviot variety, they are liable to develop, in the milling of the fabric, curly features.

Alpaca noils are fine in the fibre, spin to a good length and make a bright, smooth yarn. Their diffusiveness, unless blended with wool to improve their carding property, causes them to give off a fair percentage of "fly" in the carding operation. Cashmere and camelhair noils are likewise small in the hair and remarkably soft in the handle. Both are utilized in the manufacture of high-grade goods with a smooth or fibrous finish. Camelhair noils are fawn in colour, while alpaca noils are obtainable in the white, grey or brown.

Descriptive particulars of different classes of noils, and of their uses in the woollen industry, are given below—

Botany or Merino Noils—Fig. 16, *Specimen A.*

The sample is suggestive of the wool used in making fine merino or Botany worsted yarn. The noil is a 70's quality, snow white in colour, and fine and short in fibre. The neppiness of the staple is clearly distinguishable.. For producing specked and spotted fabrics, part of the clustered filaments may be allowed to run unopened into the condensed sliver. If this should be done, the selected noils are dropped on to the last swift of condenser. This practice has been followed in the manufacture of the yarns in the tweed specimens

in Figs. 17 and 18, in which two shades—dark and light—of neppy noils have been thus used. Noils of this class have, however, a more general application than to this special variety of fancy suiting goods. In making high-class woollens—composed of medium or small yarns—the fibres, in the carding operation, are searchingly separated and intermingled, and an even thread is formed, usable in the manufacture of face-finished goods; or the noils, when so treated, are employed in yarns for twisting purposes, in which case they enter into twist-yarn fabrics of the Bedford cord, whip cord, and buckskin class.

Crossbred Noils—Fig. 16, *Specimen B.*

When specimens *A* and *B* in Fig. 16 are compared, the distinctions in fibre fineness, staple quality, and colour tone, between merino and crossbred noils, are at once observed. These different features and properties necessarily affect the applications of the two materials. Sample *B* is typical of the medium crossbred noils, namely a 30's variety. It is obviously a desirable fleece-wool substitute, being strong in the fibre, a fair colour, and in a cardable condition, and also less neppy in character than Sample *A*. This description of noils is selected for the manufacture of the better classes of fancy tweeds, and made of yarns ranging from 16 to 24 yds. per dram.

White Alpaca Noils—Fig. 19, *Specimen A.*

The average length of staple in this specimen is 1 in., but the noils contain a small percentage of fibre 2 ins. long. The material is open in condition, and the fibres straight and uniform in character. It is adapted for blending with good shoddy or a moderate quality

Fig. 17

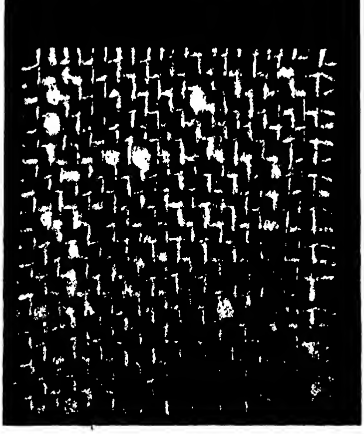


Fig. 18

TWEED SPECIMENS

(In the manufacture of which part Noppy Noils have been used)

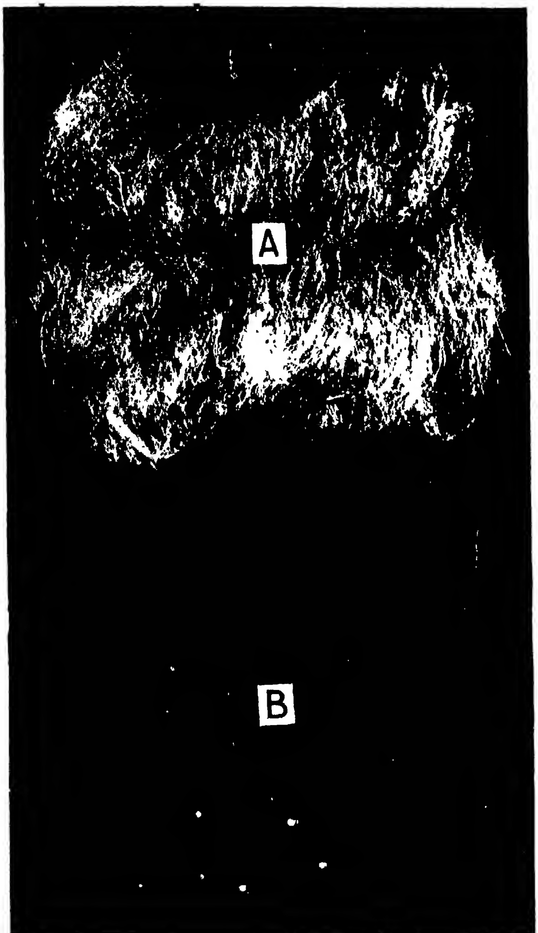


Fig. 19

SPECIMEN A: WHITE ALPACA NOILS
SPECIMEN B: BROWNISH-GREY ALPACA NOILS

of wool. The vegetable matter, seen in this noil, is so loosely attached to the fibres that it may be extracted by the clothing teeth of the workers and strippers in the process of carding.

Brownish-Grey Alpaca Noils—Fig. 19, *Specimen B (Samples C and D.)*

Sample *C* in these noils is from the first combing, and Sample *D* from the second combing. Both specimens are of a similar filament length, but the fibres are better separated and straighter in the latter than in the former, with practically the whole of the vegetable matter removed. Such noils form a staple suitable for admixture with fine wools, to develop "hairy" yarns, particularly those used in producing the textural qualities in stripings *H* of Fig. 20. In the yarns applied in making this fabric, the wool ingredient gives thread density, and the noil ingredient yields, in raising the cloth, the fibrous surface observed in parts *H*.

Mohair Noils—Fig. 21, *Specimens A and B*

The upper sample is from the first combing. In addition to containing seeds, motes, etc., this noil is shorter and more irregular in staple than Sample *B*, which is from the second combing. The fibre length and fibre diameter are of an average standard for blending with medium Crossbred or Cheviot wools and sound shoddy.

White Cashmere Noils—Fig. 22, *Specimen A*

A fine-fibred, short-stapled noil, extremely soft in texture, and usable in making high counts of yarn when admixed with fine wools.

Fawn Cashmere Noils—Fig. 22, Specimen B

Similar to *A*. Both specimens contain a percentage of neppy fibre, which would necessitate the use of fine counts of card clothing and close setting in carding.

Camelhair Noils—Fig. 23, Specimens A and B

The samples are derived from the first and second combings respectively. They are of a like softness and

H FIG. 20 H

COSTUME CLOTH

(Part made of Lustre Noils)

fineness to cashmere noils, but somewhat less downy in nature. Here the filament length is well equalized. The material is in a better prepared condition for carding in Sample *B* than in Sample *A*. Both these noils are naturally fawn in colour.

Process Wastes

In woollen manufacture there is a varying supply of waste fibrous product from the processes of yarn and fabric construction. The methods of classifying, and also of re-utilizing this material, depends on its staple and on the source from which it is obtained; but, in

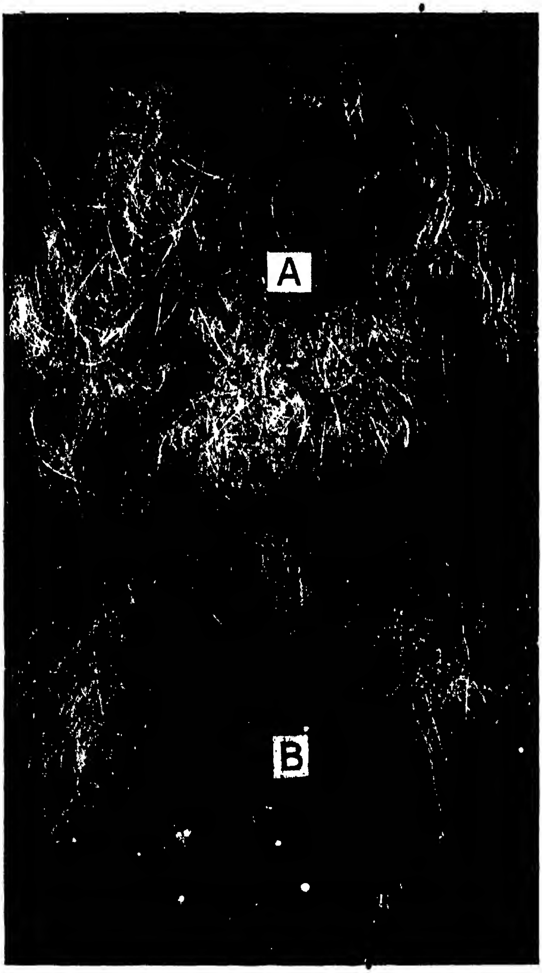


FIG. 21

SPECIMEN A: TURKEY MOHAIR NOILS (1ST COMBING)
SPECIMEN B: TURKEY MOHAIR NOILS (2ND COMBING)

all well-organized factories, there is a definite system of collecting "waste" fibre into sorts, and of using it in yarn making.

A practice commonly adopted covers each sort of material resulting from the different operations, thus—

1. From the processes of wool sorting, scouring and burring, there accumulates a quantity of short locks of wool, which may contain a proportion of vegetable matter. These, with the burry wool, removed by the burr rollers in carding, are carbonized, and may be dyed black or a dark colour, and afterwards applied in the production of mixture yarns.

2. In the "teazer" and in the "fearnought" some loose fibre escapes from the machines, which, after passing through the "shaker"—Fig. 6—to take out the dust and other foreign substances, is suitable for re-blending with a lower stock of material, or for dyeing into dark shades, and as the body colour in producing mixture yarns.

3. In scribbling and carding three kinds of waste are formed—(*a*) that which is given off as "fly," or fluffy fibre, by the workers, strippers and fancy; (*b*) that which falls under the machines; and (*c*) that consisting of defective and broken slivers. The wastes from class (*a*) are employed in mixing fresh lots; from class (*b*) they are separated from the dust, etc., and then used in inferior blends; and from class (*c*), with the sliver waste from spinning, the wastes are regularly replaced in the automatic feed of the scribbler to be re-worked.

4. In spinning, there are two sorts of waste classed as *soft* (bits of condensed slivers—and dealt with as explained) and *hard*, consisting of twitty and other pieces of yarn, which are subsequently pulled and Garnetted for use in other stock.

It may be observed that shady pieces are sometimes

caused by a difference in the counts and spin of the yarns at the commencement and finishing of a lot in making face and high-class goods; hence, such yarn wastes should be treated as distinct, in cloth manufacture, from the bulk yarn wastes in the lots.

5. In twisting and doubling, the "waste" yarns are Garnetted unless they contain cotton, in which instance they are carbonized and then pulled.

6. Warping and weaving "waste" consists of yarn known as warp thrum and of weavers' waste. Thrum is the short length of warp produced in starting the loom in weaving fresh piece lengths. It may be quite different in quality from the yarn used in wefting. Both "wastes" are dealt with in the Garnett machine and may be re-dyed, if the quantities are not sufficient to use separately, or they may be stocked and blended systematically for the manufacture of new goods.

7. Waste derived from the processes of scouring, milling, raising and cutting, which will be considered under "flocks."

Pulled-Yarn Waste

This, as a by-product, is the next in importance to noils, being obtained after the wool or fibrous material has been spun into yarn. It results from separating fibre from fibre of such yarns, whether waste from spinning, winding, warping, or weaving.

There are three descriptions of this pulled waste—that from factories producing all-wool goods, that from factories producing bi-fibred goods, and that from worsted spinning mills. The two former should, as a rule, be handled in the factories in which they are made, where the machinery should include one or more Garnett machines. Bi-fibred yarns necessarily require to be extracted before pulling. The woollen yarn

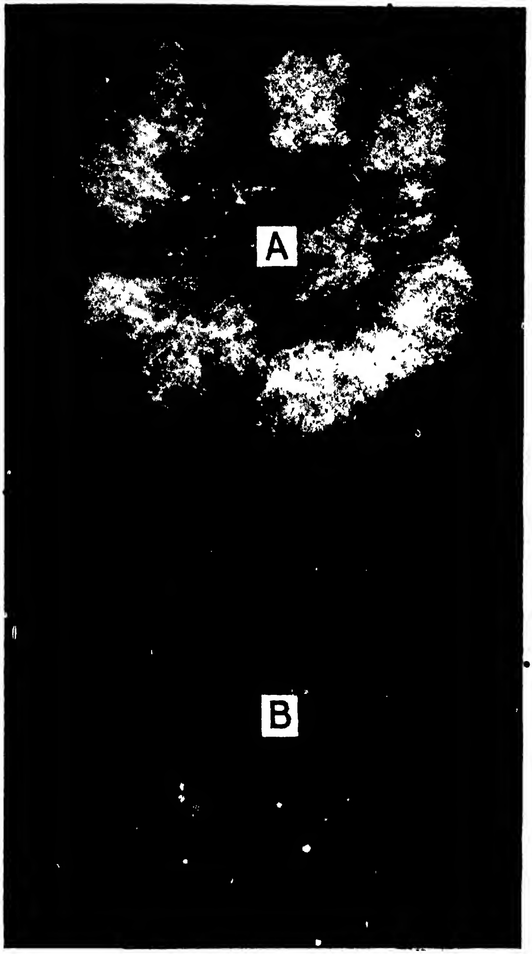


Fig. 22

CASHMERE NOILS

FIG. 23

CAMELHAIR NOILS

(Specimen A : From 1st Combing. Specimen B : From 2nd Combing)

wastes should be regularly collected, graded, and reduced to a wool substitute.

From worsted spinning mills a constant marketable supply of this class of waste yarn is obtainable. Like noils, it is a pure wool product, when resulting from English combing; but there are, in addition, waste yarns derived from French combing, which may be an admixture of wool and cotton, as also worsted yarns, in which, in the operations of doubling and twisting, cotton threads are combined with the worsted threads, and in all these yarns the cotton has to be removed by carbonizing.

Prior to 1850, worsted-yarn by-products were only considered as fit for cleaning waste. Now they are of such intrinsic value as to be extensively used in woollen factories, in which the better as well as the medium grades of fabrics are produced. They represent an annual British supply of recovered wool fibre amounting to, approximately, 30,000,000 lb.

When the yarn-pulling machine was introduced, the common custom was to store such "waste" as a kind of refuse. It is said that the inventor of the machine approached a firm of carpet manufacturers having a huge heap of this sort of waste yarn stored in the mill yard, and received permission to experiment in pulling it. The result was what may be defined as a "yarn-shoddy," which has become such an important material in the woollen industry.

As the worsted spinning trade is divisible into Botany, Crossbred, Mohair, Alpaca, Camelhair and Cashmere yarns, there are pulled wastes made of staples of these different materials. The type of yarn Garnetted is, therefore, an index to the sort of pulled waste producible. Seeing, however, that each of these classes of yarn is made in several qualities, varying with the fineness of the fibre from which the yarn is spun, it does not follow

that the material derived from Botany, Crossbred, Mohair, and other yarns, is of the same manufacturing qualities and value as suggested by the description of yarns from which they are derived.

The classification is sound as to the general characteristics of each by-product; but experience and

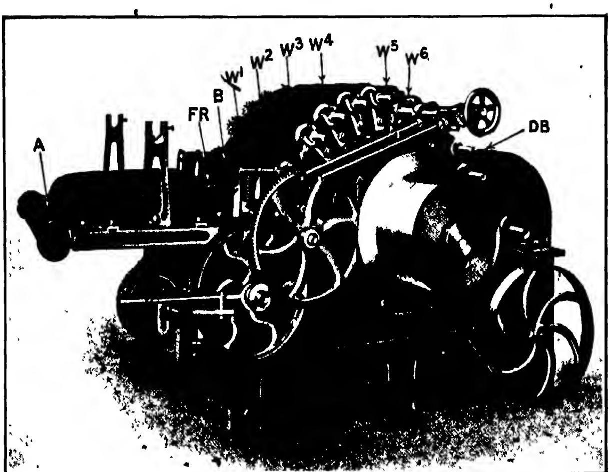


Fig. 24

PREPARER OR KNOTBREAKER

judgment in the using and application of such recovered wool, enables the manufacturer to distinguish between the pulled waste from the finer and medium Botany, or from the medium and coarser Crossbred, etc.

The fibre reclaimed from Botany yarn is of good spinning, dyeing, and finishing characteristics; and may, in consequence, be used with merino wools in producing yarns for fine woollen cloths. The better qualities of pulled Crossbred waste are usable in the

fancy woollen trade, and the medium and lower qualities in the Cheviot trade.

The lustrous and spinning properties of Alpaca, Cashmere and Lustre wools, make the waste material, obtained from their re-manufacture, adapted for admixture with wools in the preparation of hairy or fibrous yarns, applied in the dress trade, particularly

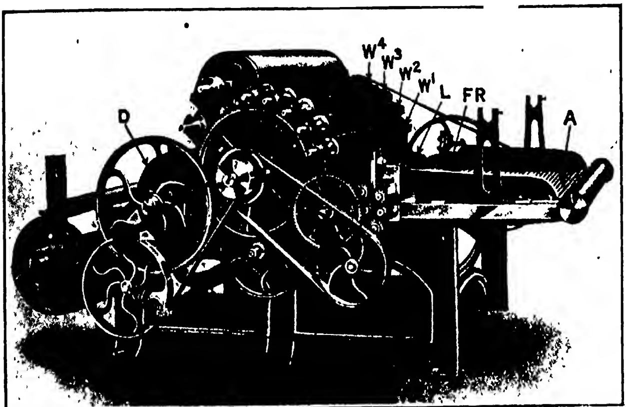


Fig. 25

SINGLE-SWIFT GARNETT

to textures which are slightly milled, and raised in a damp condition to develop surface fibre. The length, as well as the brightness of the filament got from the pulling of yarns composed of these materials, have led to their use, to some extent, in the production of yarns for carpets, and to a larger degree in yarns for hosiery purposes. For fancy knop yarns, such as those appearing in Sections *H* of Fig. 20, Alpaca, Mohair, and similar pulled wastes are employed. The length of the fibre of which they are made, when the cloths are raised,

produces the drawn patches of fibre seen in the specimen.

Garnetting is the practice by which spun and twisted waste yarns are changed into a fibrous material suitable for carding and spinning, and the work is done on Garnett machinery. This is somewhat similar in form of construction to the "Fearnought," in the single-swift machine, and to the "scribbler" or "carder" in multi-swift machines.

The Garnett machines illustrated comprise—

Fig. 24. Preparer or Knotbreaker.
" 25. Single-Swift Garnett.
" 26. Sectional Drawing of Single-Swift Garnett.
" 27. Three-Swift Garnett.

The "preparer," or "knotbreaker"—Fig. 24—is designed and built for destroying all knots, and hard and twitty portions of yarn, before treating the material on the waste opener. The swift of this machine is 24 in. in diameter, and has a running speed of 450 revs. per min. Over the swift—Fig. 24—are several workers —W^1 to W^6—4½ in. in diameter and making 16 to 20 revs. per min. These rollers are positively or wheel driven off the main shaft.

The yarn waste is carried by the feed sheet *A* to the feed rollers *FR*, which submit the material to the teeth of the licker-in, *L*. The cylinder or swift *S*, Fig. 26, on account of its high speed and superficial area, forces the material forward from worker to worker. On reaching the last roller W^6, the separated fibrous product is removed from the machine by the doffer *D*, and the doffer comb *DC*.

On the "waste opener" the real operation of reducing the ends of yarn to a filament condition is effected. The two-swift machine is used on both woollen and worsted yarns, and the single-swift machine —Figs. 25 and 26—on yarns of a softer and of a more loosely twisted character. The three-swift Garnett—

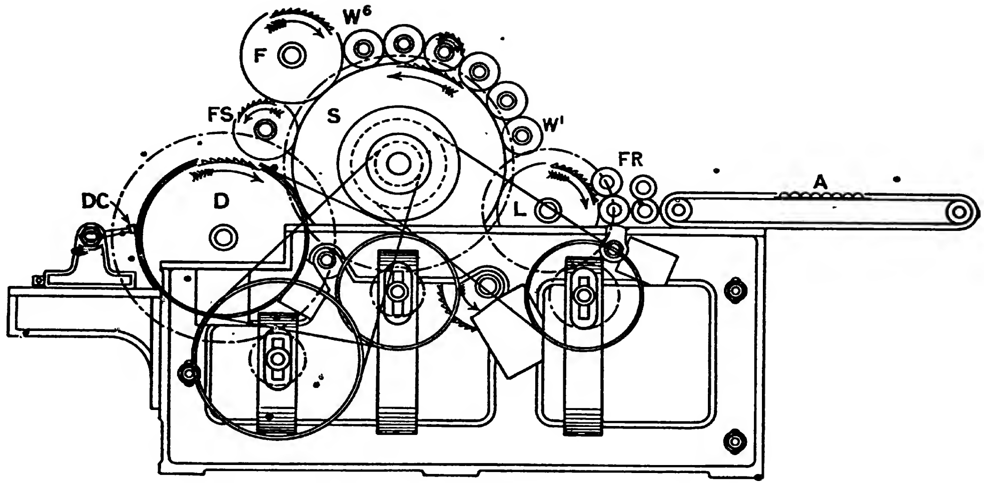


Fig. 26

SECTIONAL DRAWING OF SINGLE-SWIFT WASTE OPENER

Fig. 27—is suitable for dealing with Botany waste, single, and two-fold yarns; but the two-swift Garnett, with six workers on each cylinder in place of four or five, is also used on these yarns. The larger number of workers adds to the thread-opening efficiency of the machine.

The principle of the operation of garnetting is the same in each class of "waste opener." Passing from the feed table *A*—Figs. 25 and 26—it is engaged by two pairs of feed rollers *FR*, and drawn from them into the machine by the licker-in *L*, when it is acted upon by the steel teeth of the cylinder. On the upper surface of *S* there revolve six rollers for converting the lengths of yarn to filament units; the "fancy" *F*, for raising the material on to the points of the teeth of the swift, and tho "fancy stripper" *FS*. The doffer, *D*, is for clearing the cylinder.

Before the "waste" reaches the swift the yarns undergo a certain amount of breaking up by the action of the feed rollers and the licker-in. In the three-swift machine—Fig. 27—from the doffer, D^1, the partially open material is engaged by the pointed steel clothing of the second swift, S^2, on which the process of thread tearing up and fibre separation is continued as on the first swift; with the operation continued on the third cylinder, S^3. The material is finally stripped from the machine by the doffing comb, *DC*. This has a rapid up-and-down motion, and in the down stroke it clears the teeth of the clothing of the doffer of the prepared fibre.

The approximate speeds of the lattice feed and of the several rollers are—

Lattice Feed Table A, Fig. 27	Traverse, 6″ per min.
Feed Rollers, FR.	1 rev. per min.
Licker-in, L.	140 revs. per min.
Swifts, S^1, S^2, S^3	245–300 " "
Workers, W^1 to W^{10}	20–40 " "
Fancies, F^1, F^2, F^3	1,500 " "
Fancy Strippers, F.S^1, F.S^2, F.S^3	235 " "
Doffers, D^1, D^2, D^3.	10–16 " "

The wire teeth clothing for the cylinders, workers, fancies and strippers is of the keen-angled, pointed type shown at Fig. 28*B*, and that of the first licker-in of the flat form shown at Fig. 28*C*, which is also applied to the burr rollers in the worsted carder. For the feed rollers, the covering contains four to six teeth per inch, and for the other rollers eight to thirty-two, but more generally eight to twenty or twenty-four. When the material is hard spun or hard twisted, the workers are set closer to the swift, and their speed and that of the doffers is lowered, in order to retain the material for a longer period under the tearing action of the teeth of the different rollers.

Other particulars and working data relative to the different machines are appended—

Preparer or Knotbreaker, Figs. 24 and 25

Diameters of Rollers.

Swift, 26″; Workers, 4½″; Doffing Brush, 20″.

Working Width of Machine.	*Diameter of Driving Pulley.*	*H.P. in Driving.*	*Speed of Swifts.*	*Productive Capacity-lbs. per hour.*
24″	15″	5	450 revs.	120–180
36″	15″	5½	450 ,,	180–240
48″	15″	6	450 ,,	220–300

Waste Openers

Type Fig. 25. With one, two, or three Swifts, and five or six Workers on each Swift, for pulling woollen or worsted yarn waste.

Diameters of Rollers.

Feed Rollers, 2½″; 1st Lickerin, 12″; 2nd Lickerin, 9″;
Swifts, . 20″; Doffers, 16″; Workers, . 4″;
Fancies, . 9″; Fancy Strippers, 6″.

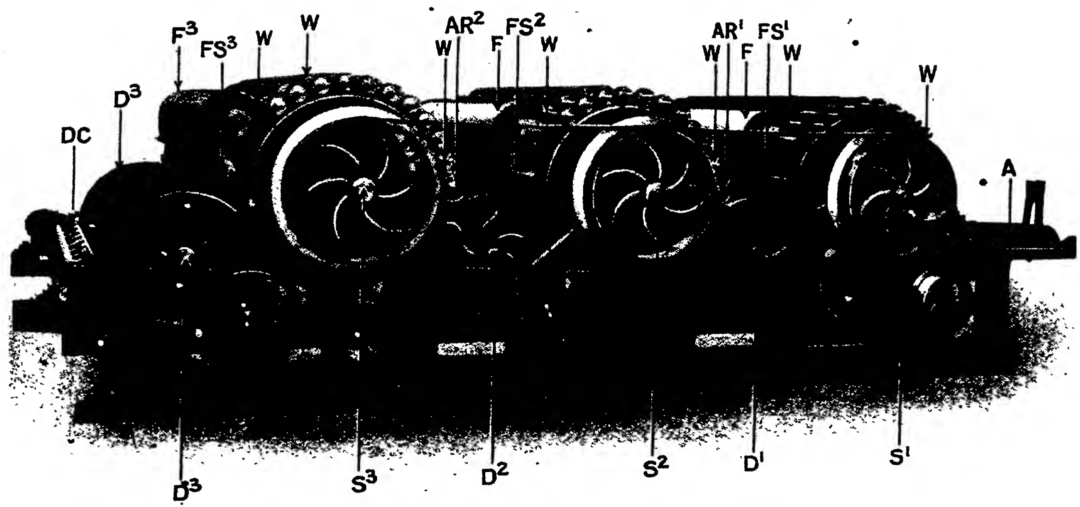


Fig. 27
THREE-SWIFT GARNETT

With one Swift.

Working Width of Machine.	*Diameter of Driving Pulley*	*H.P. in Driving.*	*Speed of Swift.*	*Productive Capacity-lbs. per hour.*
24″	15″	1	285 revs.	10-35
36″	15″	1¼	285 ,,	15-50
48″	15″	1½	285 ,,	25-65
60″	15″	1¾	285 ,,	25-85

With two Swifts.

24″	15″	2	285 revs.	10-35
36″	15″	2¼	285 ,,	15-50
48″	15″	3	285 ,,	20-65
60″	15″	3½	285 ,,	25-85

With three Swifts.

24″	15″	3½	285 revs.	10-35
36″	15″	4¼	285 ,,	15-50
48″	15″	5	285 ,,	20-65
60″	15″	5¾	285 ,,	25-85

Waste Opener—Type, Fig. 27

With one, two or three Swifts, with ten or eleven workers on each Swift, usable in the opening of all kinds of hard-twisted, woollen, worsted and silk wastes, hosiery, clippings, etc., and with the rollers clothed with *electrically hardened and tempered steel wire,* from 10 to 24 rows per inch, according to the material to be opened.

Diameters of Rollers.

Feed Rollers, 2¼″; 1st Lickerin, 12″; 2nd and 3rd Lickerin, 9″;
Swifts, . 30″; Doffers, . 24″; Workers, . . 4″;
Fancies, . 11″; Fancy Strippers, 6″.

With one Swift.

Working Width of Machine.	*Diameter of Driving Pulley.*	*H.P. in Driving.*	*Speed of Swifts.*	*Productive Capacity-lbs. in 10 hours.*
36″	15″	1	285 revs.	180
48″	15″	1¼	285 ,,	240
60″	15″	2	285 ,,	300

With two Swifts.

36″	15″	2¼	285 revs.	180
48″	15″	2¾	285 „	240
60″	15″	3	285 „	300

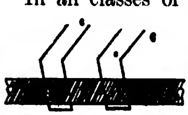
With three Swifts.

36″	15″	3¾	285 revs.	180
48″	15″	4¼	285 „	240
60″	15″	4¾	285 „	300

Garnett Wire

As pointed out, the knotbreaker, waste-opener and each description of Garnett machine resembles in construction, design and arrangement the machinery used in scribbling and carding. The functional parts of the former are identical in character with those of the latter, though the two types of machines are used for different varieties of material and for distinctive purposes—the Garnett for the reduction of waste yarns to a fibrous product, and the carder for the opening and re-blending of filament substances, such as wool, mungo, extract and cotton. Thus, as shown, both forms of machinery comprise the following rollers: "feeds," "taker-in" or "licker-in," "cylinders" or "swifts"; with the "workers" and strippers placed over the swift, and the "doffer" set below the cylinder or swift. One feature in which they essentially differ is in the type and construction of the metal teeth of which the "clothing" consists on the various rollers.

In all classes of carding machinery the "clothing" is made of hard-tempered wire pricked through a cloth composition or leather foundation in the manner sketched. The wire, being bent or knee-formed, is specially adapted for holding and also, in passing in close proximity



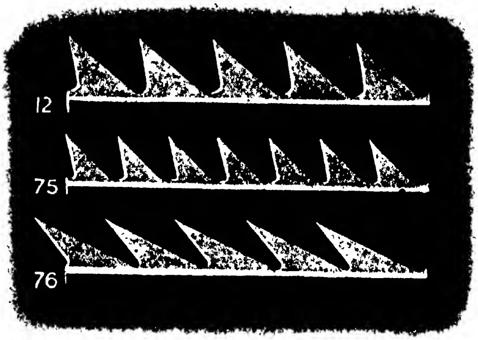


Fig. 28A

GARNETT WIRE FOR ROLLERS OF KNOTBREAKER

(*Numerals = Makers' References*)

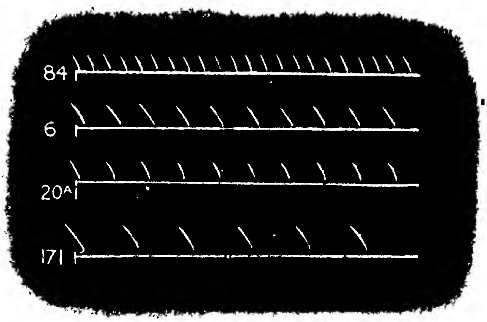


Fig. 28B

GARNETT WIRE FOR ROLLERS OF WASTE OPENER

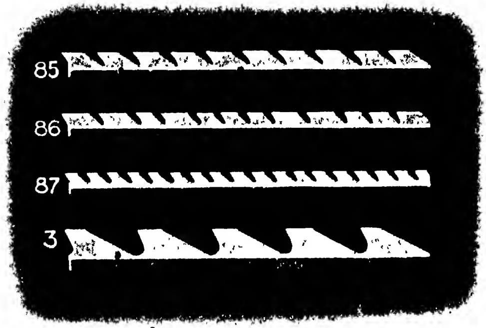


FIG. 28C

GARNETT WIRE FOR BURR ROLLERS OF CARDING MACHINES

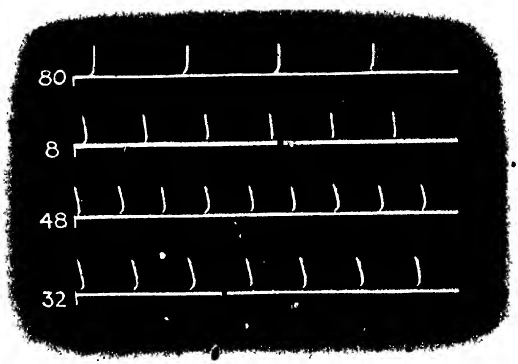


FIG. 28D.

GARNETT WIRE FOR "LICKER-IN" ROLLERS OF COTTON CARDER

the wire of another active roller, for disentangling the matted portions of the material, and for literally separating the filaments from each other. Its efficiency is also seen in the systematized commingling of the

FIG. 29
SECTION OF ROLLER COVERED WITH "GARNETT" WIRE

fibres so treated into a fleecy web. From this it will be understood that wire teeth "clothing" used in carding is more or less pliable, whereas the teeth of Garnett wire, being part of a metal piece, are rigid and firm, and have, in the application, operative and resistance power. Their rigidity, strength and compact setting on the rollers, plus their saw-like, wedge-shape or serrated form—Figs. 28A, 28B, 28C and 28D—cause their points to be effective in attacking, retaining,

opening out and disintegrating the twisted structure of waste yarns however entangled, knotted or hard in twine.

Prior to 1850, or to the invention of this class of metal-toothed wire, by the late Mr. Arthur Garnett, of Otley, two kinds of "clothing" were used for opening and carding machines—wood lags set with pins, and wire teeth as described. The latter have the advantage over other makes of "clothing" in fineness and in the

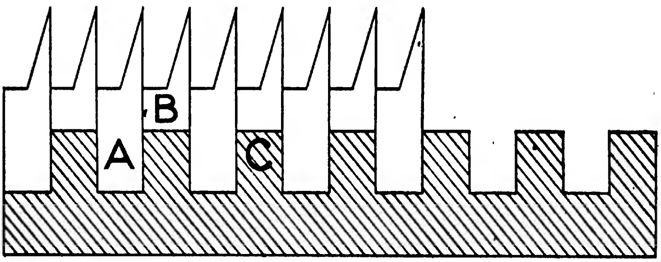


FIG. 30

LEATHER'S DOUBLE-ROW SETTING OF GARNETT WIRE

number of points possible in a given area of the roller surface covered; and on this account such wire clothing is universally employed in the operation of carding. But saw or wedge-shape teeth have the advantage in the treatment of waste-yarn by-products with a view of reducing them to a fibrous material, but not for working them into a suitable condition for thread preparation.

Garnett wire is not nailed on to the rollers as in the practice of applying "card wire," but set in grooves—varying in gauge with that of the wire selected—of the rollers as illustrated in Fig. 29. Here the serial and secure setting of the teeth are observed. The points of the teeth of the various rows of the wire are not in absolute line from side to side of the roller, but conform

in average number in a measured pattern of the roller surface.

As a consequence of improvements in the make of the wire by the late H. T. Leather in 1878, the number of teeth per square inch of surface was increased by setting the wires in the grooves of the rollers in *double* instead of in *single* rows, in the system outlined in Fig. 30, the shaded details represent a section of the cast-iron cylinder, grooved to receive the rows of the deep-ribbed wires *A*, between which are inserted rows of the shallow-ribbed wires *B*. Formerly, when waste-opening machines were covered with metal teeth arranged in single rows, 12 to 14 rows per inch was the maximum, whereas, on the improved principle of wire construction and setting, some 20, 24, 26 or more rows per inch are feasible. This increase in the number of rows of teeth on a roller surface has raised the working efficiency of this class of machine and also of Garnetted rollers applied to scribbling and carding machinery.

Types of Garnett Wire and Applications

Illustrations of different makes of Garnett wire are given in Figs. 28A to D. A strong, firm class of wire, with comparatively a small number of teeth per inch, is used for the rollers of knotbreakers and preparers. With the yarns meshed and hard-twisted and also knotted, they necessitate the dividing and opening action of rollers, clothed with wire of the types shown at Fig. 28A; or of wire having saw teeth cut at an angle for ensuring the points firmly gripping the material, and for retaining it till fully separated by the teeth of an adjacent roller. For feed rollers long-toothed wire is employed, grooving the rollers 3, 4 or 5 rows per inch, according to the nature and quality of the waste yarns treated, the grooves in one roller being cut with a right-hand thread and those in the second roller with a

left-hand thread, as in Fig. 31. This causes the rows of teeth, when the rollers are in an operative relation, to intersect, so that the grip of the teeth on the material is augmented; while the long-form of teeth provides for the waste yarns being regularly delivered into the machine without unduly damaging the staple of the materials of which such yarns are composed.

FIG. 31
GARNETT "CLOTHED" FEED ROLLERS

Reference has been made in Chapter IV to the waste wool fibre containing burrs and vegetable matter resulting from the carding process and also to the methods of its utilization. This fibre collects on the burr rollers of the carder, which are clothed with fine Garnett wire, punched with a small space between the teeth, and with the rows of wires so closely set in relation to each other that it becomes impracticable for the burrs, motes, seeds and shives in the staple of the wool to penetrate below the surface of the "clothing." Such burr rollers are set on the English system near to the taker-in rollers, and vary in number with the description of wool being treated. On the Continental system they may be placed in the rear of the breast cylinder or between the first and second swifts in a two-swift machine. Burr rollers are "clothed" with single or double rows of wire of the flat-toothed type —see Fig. 28c—or the wire may be fitted on to the rollers

without grooving, that is, by pressing it into the rollers in correct serial order. In either instance the extreme fineness and compactness of the teeth only allow of the wool filament being embedded in the clothing, with burrs left on the points of the teeth. For each burr roller there is a "guard" roller, the blades of which beat the burrs, etc., off the teeth into a tray or metal receiver. Any particles of wool fibre adhering to the burrs and other foreign matter so removed are collected and carbonized.

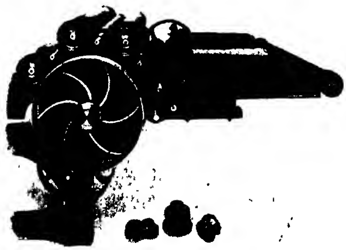


FIG. 32

GARNETT BREAST CYLINDER FOR CARDERS

Another application of Garnett wire is to the taker-in and other preliminary rollers of the scribbler and carder. Should the material utilized be matted, meshed and felted, and therefore difficult to work, it is advantageous to employ a "breast" part, mounted with Garnett clothing or the mechanism shown in Fig. 32. It consists of feed rollers, taker-in, and of a small swift with two pairs of workers and strippers, and may be attached to any construction of scribbler. Its use adds to the life of the card clothing of the whole machine, and also results in better carded slivers.

The table appended shows the quantities in pounds of Garnett wire requisite in the clothing of the different

rollers of preparers, and waste-openers, and of special rollers in carding machines.

Type of Machine and Class of Roller.	*Dimensions of Roller Surface Cut and Rows of Wire.*	*Weight.*
1 Swift of "Garnett" machine .	60 in. × 30 in. cut 8, 10 or 12 .	70 lbs.
1 " " " .	60 in. × 30 in. " 16, 20, 24 or 26 .	170 "
1 Doffer " " .	60 in. × 24 in. " 8, 10 or 12 .	56 "
1 " " " .	60 in. × 24 in. " 16, 20, 24 or 26 .	136 "
1 Swift " " .	60 in. × 20 in. " 8, 10 or 12 .	47 "
1 " " " .	60 in. × 20 in. " 16, 20, 24 or 26 .	113 "
1 Doffer " " .	60 in. × 16 in. " 8, 10 or 12 .	37 "
1 " " " .	60 in. × 16 in. " 16, 20, 24 or 26 .	91 "
1 Fancy " " .	60 in. × 9 in. " 8, 10, or 12 .	21 "
1 " " " .	60 in. × 9 in. " 16, 20, 24 and 26	51 "
1 Stripper " " .	60 in. × 6 in. " 8, 10 or 12 .	14 "
1 " " " .	60 in. × 6 in. " 16, 20, 24 and 26	34 "
1 Worker " " .	60 in. × 3½ in. " 8, 10 or 12 .	8 "
1 " " " .	60 in. × 3½ in. " 16, 20, 24 or 26 .	20 "
1 Licker-in " " .	60 in. × 12 in. " 6	31 "
1 " " " .	60 in. × 9 in. " 6	23 "
1 Feeder " " .	60 in. × 2½ in. " 5	9 "
1 Preparer Swift . . .	48 in. × 24 in. " 5	90 "
1 " Worker . . .	48 in. × 4 in. " 5	15 "
1 " Feeder . . .	48 in. × 3 in. " 3	7 "
1 Cotton Carder Taker-in . .	49 in. × 9 in. " 8	15 "
1 " " " . .	45 in. × 9 in. " 8	14 "
1 " " " . .	41 in. × 9 in. " 8	12½ "
1 " " " . .	37 in. × 9 in. " 8	11½ "
1 " " " . .	49 in. × 9 in. " 6	11 "
1 " " " . .	45 in. × 9 in. " 6	10 "
1 " " " . .	41 in. × 9 in. " 6	9½ "
1 " " " . .	37 in. × 9 in. " 6	8½ "

Operation of Setting Garnett Wire

The methods of applying Garnett wire and of "re-clothing" or recovering Garnett rollers should be understood in all factories in which Garnetting is done. The first essential is a screw-cutting lathe—Fig. 33—and the second essential a suitable set of machine tools —*A* to *H*, Fig. 34. The roller *A*, is placed in the lathe, having compound rests and bearings *C*, and set perfectly true. The wire *W*, is delivered from the roller *B*. It is passed over a guide *G*, and fed into the grooves of roller *A* by the mill or staking tool *E*, Fig. 34. As wiring proceeds, the roller revolves and *E*, having been correctly adjusted, follows the gauge of the grooves.

In the operation of re-clothing, the worn wire is

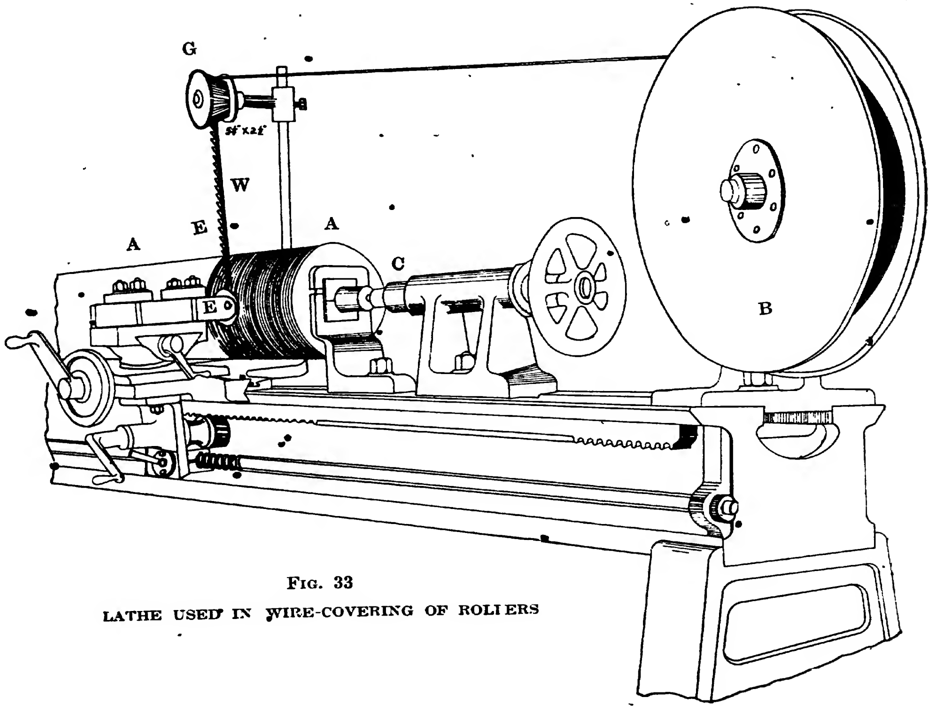


FIG. 33

LATHE USED IN WIRE-COVERING OF ROLIERS

removed from the grooves of the roller by tool *B* (Fig. 34), which should be set close to the roller surface, but not in actual contact with it. On the other hand, if the wire to be detached should be firmly embedded in the roller grooves, tool *A* is selected and the edge of the tool is fixed to enter slightly into the grooves. The tool *C* is for freeing the end of the wire before running

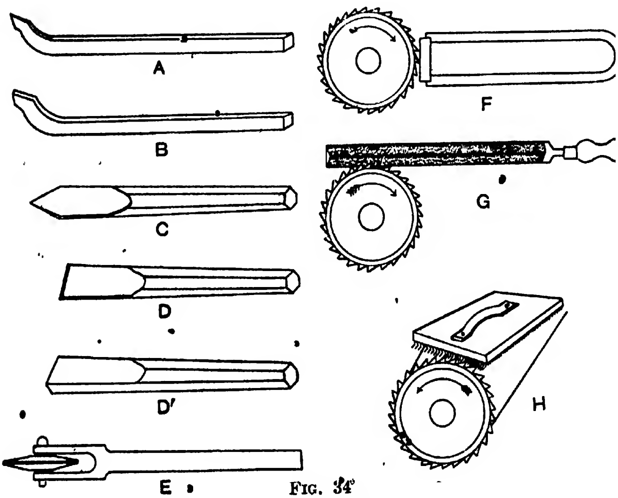


FIG. 34

TOOLS USED IN THE CLOTHING OF ROLLERS WITH GARNETT WIRE

off, and the chisel *D* for cutting the teeth accurately at the sides or ends of the roller. The "set" *D′* is for "caulking" ends and points by slightly tapping the roller *A* for some few inches along the edge of the wire, rendering it secure in the groove. Should the grooves in the roller be worn shallow, the ridge or base of the wire may be filed for about two inches from each end of the portion of the groove it is required to fit. This ensures the rib of the wire being below the surface of the roller.

It is imperative that the correct gauge of wire for the dimensions of the grooves should be applied. If the wire is too thick in the ridge, the amount of undue pressure applied in forcing it into the groove is liable to cause the roller shaft to be warped or otherwise damaged. On the completion of the covering of a roller, approximately four teeth should be cut off from each end of the wire, which facilitates the "caulking" of the teeth of the clothing at the ends of the roller.

Grinding

Dronsfield's wire-mounting and grinding machine is illustrated in Fig. 35. The machine is fitted with a wire-feeding stand, *S*, with a traverse-wheel grinder, and with a dressing tool for straightening and aligning the teeth in defective rollers. If employed instead of a screw-cutting lathe, the wire runs off *S* through the mechanical traverse guide *B*, which places the wire in the grooves of the roller *A*.

The machine is also employed in "topping" or "grinding" Garnetted rollers. In this operation the "clothed" roller revolves at a surface speed of some 400 ft. per minute the reverse way from that in which it is clothed, or with the teeth of the wire in a "biting" direction. Trueing-up is first effected by placing the topping file or emery block, *F*, Fig. 34, in the holder, when the file is brought into gentle contact with the wire, traversing from one side of the roller to the other. This done, the feather-edge file *G*, Fig. 34, is held firmly against the wire and moved across the roller as many times as there are rows of wires per inch, the motion of the roller being stopped after each traverse, to enable the file being placed in the correct rows of the wires. Burnishing is the final process. A small percentage of oil is applied to the roller when it is made

to revolve at a surface speed of 600 ft. per minute, with the teeth pointing in the opposite direction to the circular movement, and with the teeth in contact with the wire of the hand card *H*, Fig. 34, until all teeth are perfectly smooth.

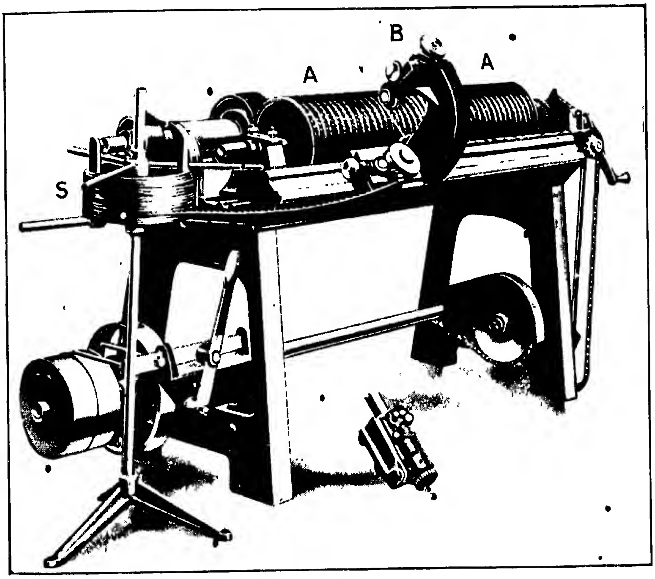


FIG. 35
DRONSFIELD WIRE-COVERING AND GRINDING MACHINE

Roller "Re-clothing"

The re-clothing of rollers with Garnett wire is performed in a similar way as the application of the wire to new rollers. The wire should, in the first place, be regulated to the required size A number of short lengths are broken off the wire as it passes through the "mangle" and tested. The starting end is then made

secure on the roller, and the wire is ready for setting into the groove. Before starting the lathe the "staking" wheel—*E*, Fig. 34—is brought into position and just the amount of pressure applied to force the wire firmly to the bottom of the groove; that is, a lift of 3 to 4 lbs. should result in the wire being removed. During the working of the lathe it is important that the "staking" wheel should run in the centre of its axle pin, as it should not be allowed to run in contact with the inside of its holder. Piecenings in the wire are detected on passing the "mangle" and notified to the operative on the lathe. Should they not be detected, the staking wheel requires to be twined out and the lathe stopped. If the piecening occurs in the last few feet of the wire, the lathe should be worked by hand until the staking wheel is actually on the end of the wire. The lathe is next turned backward and forward four or five rounds, the staking wheel meanwhile pressing the extreme end of the wire. This effected, the second end of the wire is placed in the staking wheel touching the first end, and the lathe operated for a few inches backward and forward. The piecening thus made, should be located on the roller and marked, for it is not desirable to "caulk" the joint until a further portion of the roller has been "re-clothed."

In double-row wire recovering, the *A* wire, Fig. 30, is forced into the groove in the same manner as a single-row wire, and forms a groove for the *B* wire. Excessive pressure on wire *A* is to be avoided in double-row setting. It tends to bruise the rib of the wire and to diminish the groove for wire *B*, causing the latter to be difficult to insert. Mangling the wire to render it the proper size to fit the groove flattens or rolls the wire unduly, so that the points of the wire *B* or *C* are liable to stand higher in the "clothing" than the points of wire *A*, which it is essential to obviate.

Flocks.

Flocks are of two distinct classes—(1) the material resulting from the scouring, felting, raising, brushing and cutting processes in finishing; and (2) the material acquired by the mechanical action of the rag grinding machine in tearing rags of old, worn fabrics, chiefly of the lower and union qualities, and which yield what is known as "rag flocks."

The first variety originated prior to the introduction of shoddy and mungo, pulled waste and other wool substitutes, having been obtained from the operations of scouring, milling, raising and cutting from the early days of manufacturing, and used for bedding and upholstery purposes. Thus, in the processes to which woollen pieces are subjected in finishing, there is given off, or "shed," in scouring and milling, and removed from the cloth in raising, and cut from the cloth in cropping, a percentage of loose fibre which is termed in the trade "woollen flocks."

From the same classes of pieces the scouring, milling, and raising flocks are of a similar quality and length of staple, but the cropping flocks are shorter in fibre, and chiefly used in the manufacture of flock papers.

The principal sorts of "woollen flocks" comprise— "Common," "Medium," and "Fine Darks," got from raising, milling and cutting. Other sorts, resulting from raising and milling, include—"Best Rags," from union and woollen rugs; "Light Blues," from blankets; "Fawns," from horse rugs; "Coloured" or "Best-Fancies," from fancy rugs; "Whitneys" and "Blue Whites," from the raising of fine white blankets; "Medium Whites" from the raising and milling of navy blankets; and "Fine Whites," from white cloth blankets.

The flock dealer collects from the cloth manufacturer the different varieties of flocks produced in the woollen industry. These are sorted, classified, and blended in the production of flocks of a standard quality and shade.

Woollen flocks are distinct from the flocks obtained from rags and used in making mattresses and bedding. The latter are defined as "manufactured," a term which is not applicable to flocks acquired from a newly woven piece, and which strictly consist of the surface filament removed either by friction or by cutting, when the piece is in a clean condition.

One of the chief applications, in the trade, of fulling and raising flocks, is in the felting of woollen goods for increasing their weight, and also modifying their colour. Neutral or coloured shades are producible, on this system, by weaving the cloth in undyed yarns, and then adding black or other coloured flocks in the process of milling.

The flock fibre, in the shrinking of the goods, enters into the body of the cloth, mingling with the fibres of which it is composed, and altering its shade tone and increasing its weight per yard. The process is known as "flocking," and, in order that it may be successfully done, it is essential, first, to use a quality of flocks of sound milling property; and, second, a proportion of flocks which will add the required weight to the piece, but a quantity which will, at the same time, be effectively retained by the fabric in the felting operation. As a rule, the flock fibre should be of a better quality than that used in the production of the piece.

The quantity of flocks applied varies. Pieces have been increased 40 per cent in weight by flocking, but at least two-thirds of the raw material should be in the yarn. The process of flocking is done at intervals during felting, applying a certain quantity before

soaping and running the pieces through the machine for distributing them evenly. As the flocks in the milling become embedded in the piece other flocks are added. It is important that the pieces should not be run too dry, otherwise the flocks fail to be felted firmly into the goods.

CHAPTER VI

BLENDING

Objects of Blending—Shoddy and Woollen Manufacturing Comparisons—Blending a Basic Process—Admixture of Different Materials and Low-price Yarn Production—Coloured Blends—Neutral Grey Shades—Use of Fleece Wool in Shoddy Blending—Wool Substitutes and Colour Scale—Mixture Shades with Shoddies as the bulk Filament Ingredient—Colour Standardization and Material Mixing—Grey Blends in Dark and Medium Tones—Blending and Pattern Origination—Process of Teazing—Mixing in the Fearnought—Construction and Working of the Machine—Preparation of different Materials for the Teazing Operations.

Two or more materials, e.g. wool substitutes, or such substitutes with cotton or wool, are blended together in yarn manufacture. Either the production of yarns of a definite quality and cost; or the production of yarns of a definite mixture shade may be the object in view. In making inexpensive yarns the price per lb. of the fibrous materials selected determines their relative proportions in the process of blending; while, in making mixture-shade yarns, the coloured tones of the materials employed determine the quantities in which they are severally combined.

Economy in yarn cost enters into the calculations in both these blending practices. The weight per yard of the cloth—its thickness and substance—depends upon the weight of yarn used in its manufacture, denoting that its intrinsic cost is based upon the value of the materials used in the yarns of which the cloth is composed. The difference, for example, of the price per yard of a mungo and of an all-wool beaver cloth, due to the difference in the cost of the materials applied in the construction of each, may equal 70 to 80 per cent.

The labour, machinery, and other costs, in producing

woollen and mungo cloths, correspond in the aggregate. Fabrics made of wool substitutes are as skilfully manufactured as high-grade goods. To acquire, from an inferior class of material, cloths clean in colour, kind to the touch, and of a satisfactory wearing quality, involves economic and competent practice in every department of manufacture. As compared with the maker of low-grade fabrics, the producer of tweeds, flannels or Saxonies, deals with an equalized quality of staple, the first using Cheviot and Crossbred wools, the second wools of the South Down and Welsh variety, and the third Merino clothing wools. Each of these producers utilize a special class of wool, and this facilitates the work of cloth manufacture, in so far as the behaviour of such wools, in the processes of scouring, dyeing, and carding, and in fabric construction and fabric milling and finishing, is capable of being averaged and standardized.

On the other hand, in the lower branches of the woollen industry, the recovered wools employed vary, to an indefinite extent, with the source from which they are obtained, and these variations are subject to being multiplied with the admixture, for economic and productive causes, of fibrous materials derived from rags, pulled yarns, and carding, spinning and finishing "wastes." Wool substitutes, thus differing in origin, are necessarily diversified in filament quality and colour beyond detail classification.

Shoddy production, as explained, mixes every description of staple into a promiscuous sort of material, in which each kind and colour of fibre may be said to lose its identity, but yet to impart tone and quality to the shoddy in the bulk.

Blending, as a basic process in manufacturing routine, has an additional function to that of intermixing different classes of fibre for acquiring their complete

and equalized combination, which, as will be shown, is the result of teazing and carding. Blending may be defined as the art and practice of grouping and mixing, in specified quantities, materials of different values, grades and colours, for yielding yarns of required manufacturing properties and characteristics.

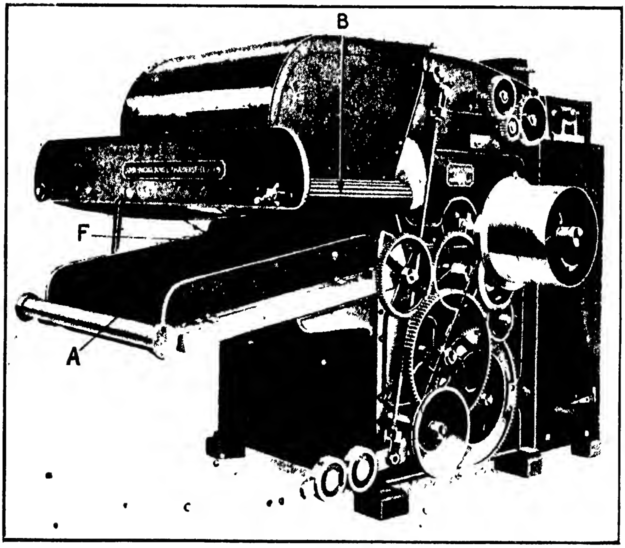


FIG. 36

HAIGH'S TEAZER

There is considerable latitude in the sorts of material which may be satisfactorily mixed, carded, and spun together. Too great a disparity in the average staple of the materials combined is, however, to be avoided. The longer fibres in a blend in which this rule should not be observed, would twirl and roll one over the other in carding, and the shorter fibres would be insufficiently

separated and distributed throughout the carded web. Medium-stapled wools are suitable for blending with shoddies and pulled Crossbred-yarn "waste"; short wools with mungo and pulled Botany-yarn "waste"; fine wool, pulled merinos, and mungo with cotton; and different varieties of wool substitutes, of an approximate staple length, may be blended with each other in such proportions as coincide with the variety and cost of a determined counts of yarn.

The subject will be dealt with primarily in its relation to the production of yarns at a low price, taking a number of typical blends—

BLEND A. *Materials:* Pulled Merinos, Pulled-Yarn Waste and Cotton. *Yarn Counts:* 8½ skeins. *Yarn Cost:* under 6d. per lb.

(Pre-war prices are given. They place on record material and labour costs which have advanced more than 200 per cent, but the basis of calculation remains unaltered.)

Material Quantities.	*Productive Costs.* £	s.	d.	£	s.	d.
1,500 lb. Pulled Merinos @ 2d. . .	12	10	–			
150 lb. Pulled-Yarn Waste @ 3d. .	1	17	6			
297 lb. Cotton @ 4d. . . .	4	19	–			
1,947	19	6	6			

Carding and Spinning Costs.

	£	s.	d.	£	s.	d.
				19	6	6
136½ lb. of Oleine (= 7% of 1,950 lb.) @ 2d.	1	2	9			
1,870 lb. of Carding and Spinning @ 2½d.	19	9	7			
	20	12	4	20	12	4
				39	18	10

£39 18s. 10d. divided by 1,870 lb. = 5.12d per lb. yarn cost.

Blend B. *Materials:* Wool, Coloured Noils, and Mungo. *Yarn Counts:* 8 skeins. *Yarn Cost:* 8½d. per lb.

Material Quantities.		*Productive Costs.* £ s. d.	£ s. d.
300 lb. Wool	@ 1/6½	22 16 3	
50 lb. Wool	@ 8d.	1 13 4	
48 lb. Coloured Noils	@ 1/1½	2 14 –	
1,401 lb. Mungo	@ 2½d.	14 11 10½	
1,799 lb.		41 15 5½	41 15 5½

Carding and Spinning Costs.

		£ s. d.	
65 lb. of Oliene	@ 2¾d.	14 10¾	
1,745 lb. Carding & Condensing	@ 1¼d.	9 1 9¼	
1,745 lb. Spinning	@ 1¼d.	9 1 9¼	
		18 18 5¼	18 18 5¼
			60 13 10¾

£60 13s. 10¾d. = Productive cost of 1,745 lb. of yarn = 8.34d. per lb.

Blend C. *Materials:* Wool, Combed Laps, Noils and Mungo. *Yarn Counts:* 10½ skeins. *Yarn Cost:* 10¼d. per lb.

Material Quantities.		*Productive Costs.* £ s. d.	£ s. d.
74 lb. of Wool	@ 1/6½	5 12 6½	
70 lb. of Wool	@ 1/–	3 10 –	
74 lb. Combed Laps	@ 1/3½	4 15 7	
37 lb. Noils	@ 1/–	1 17 –	
389 lb. Mungo	@ 2½d.	4 1 0½	
36 lb. Coloured Mungo	@ 8d.	1 4 0	
680 lb.		21 0 2	21 0 2

Carding and Spinning Costs.

		£ s. d.	
34 lb. of Oliene (5% of 680 lbs.)	@ 2¾d.	7 9½	
660 lb. Carding and Condensing	@ 1¼d.	3 8 9	
660 lb. Spinning	@ 1¼d.	3 8 9	
		7 5 3½	7 5 3½
			28 5 5½

£28 5s. 5½d. = Productive cost of 660 lb. of yarn = 10.28d. per lb.

BLEND D. *Materials:* Wool, Mungo, Flocks. *Yarn Counts:* 18 skeins. *Yarn Cost:* 1/1¾d. per lb.

Material Quantities.		*Productive Costs.* £	s.	d.	£	s.	d.
372 lb. Wool	@ 1/6¼	28	5	9			
500 lb. New Mungo (grey) .	@ 4¼d.	8	17	1			
58 lb. Flocks . . .	@ 4½d.	1	1	9			
40 lb. Inferior quality of Wool.	@ 6d.	1	–	–			
970		39	4	7	39	4	7
Carding and Spinning Costs.							
38 lb. of Oliene (= 4% of 970)	@ 2¾d.		8	8½			
931 lb. Carding . . .	@ 1¾d.	6	15	9¼			
931 lb. Spinning . . .	@ 1¾d.	6	15	9¼			
		14	–	3	14	–	3
					53	4	10

£53 4s. 10d. = Productive cost of 931 lb. of yarn = 1/1.72d. per lb.

The principle observed in each of these blends is that of using, as the bulk quantity, the lowest priced material, namely—

Pulled Merinos	@ 2½d.	in Blend	A,
Mungo . .	@ 2½d.	„	B & C,
„ . .	@ 4¼d.	„	D.

The better and more costly staples are applied in economic quantities, but in such proportions as to improve the yarn product and to give tone to the finished cloth. The idea in this blending system is to utilize the inexpensive wool substitute in forming the "lot," and to add to the spinning property and textural value of this material by combining it with staples of a superior clothing character.

Blending, for the manufacture of mixture-shade yarns, introduces colour hues, and colour tones and tints for consideration. This is exemplified, in an established form, in neutral grey shades producible by

mixing dark (or black) and light (or white) materials in such quantitative proportions as stated below—

85 parts of black or dark materials and 15 parts of white or light materials = very dark grey.
70 parts of black or dark materials and 30 parts of white or light materials = dark grey.
55 parts of black or dark materials and 45 parts of white or light materials = grey.
30 parts of black or dark materials and 70 parts of white or light materials = light grey.

Mixture shades of a corresponding tone depth are acquired in brown, green, blue and olive, by combining tones and tints of these colours in similar quantities to those indicated. For the simpler varieties of blends and in dark shades, black is admixed with the primary and secondary colours, and in light shades, white with these hues.

In both woollen and worsted yarn spinning, multi-colour blending is extensively practised. Fleece wools enable rich, warm tints and tones of colour to be selected and intermingled with each, imparting a degree of freshness to the shade resultant.* But in employing wool substitutes, the colour scale is restricted for the obvious reason that, in making cheap yarns, the larger material unit consists of mungo, shoddy or pulled waste, and this is frequently of a nondescript colour, such as a dingy grey—brownish, greenish or bluish in tone.

Four examples are appended in blends of this class. They are suggestive, in material composition and in shade quality, of the sorts of mixture yarns obtainable in the lower grades of woollen cloth manufacture—

BLEND I. *Tinted Neutral Grey.* Composed of Mungo, Merinos (extract), and Wool.

20 parts of medium grey Mungo
8 ,, white Wool
7 ,, blue Wool
5 ,, coloured Merinos

* See *Colour in Woven Design*, by the same Author and Publishers.

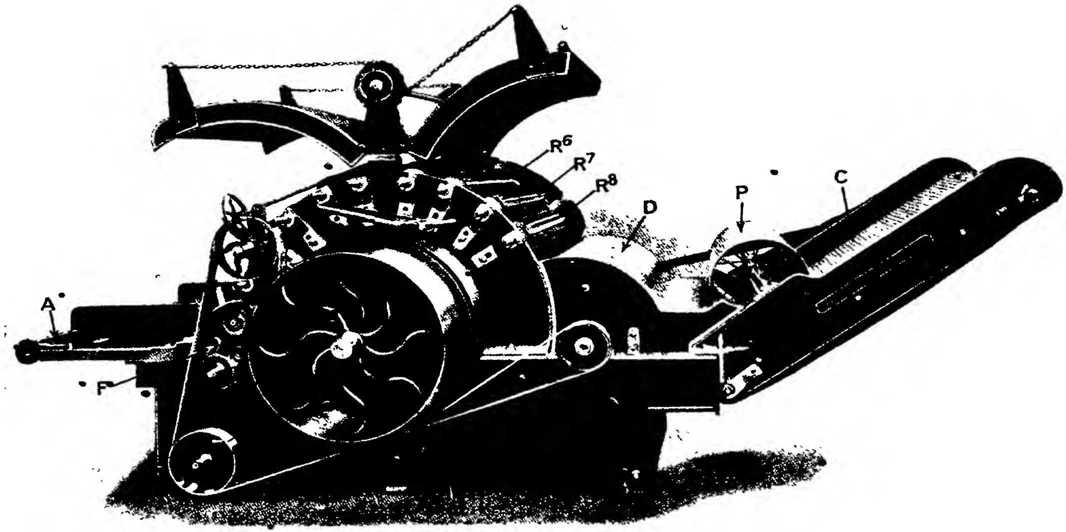


FIG. 37

HAIGH'S FEARNOUGHT

BLEND II. *Brownish Grey.* Composed of pulled Waste, Merinos (extract), and Wool.

20	parts of	medium grey Mungo
8	,,	white Wool
7	,,	fawn Wool
5	,,	light brown Merinos

BLEND III. *Greenish Grey.* Composed of Shoddy and Crossbred Wools.

12	parts of	grey Shoddy (blended)
5	,,	lavender Wool
5	,,	white Wool
2	,,	green Shoddy
2	,,	black Shoddy

BLEND IV. *Purplish Grey.* Composed of Shoddy and Crossbred Wool.

12	parts of	grey Shoddy (blended)
5	,,	black Shoddy
2	,,	purple Wool
5	,,	lavender Wool

In these examples, as in the cheaper yarn mixtures, the wool substitutes form the bulk quantity. As they are comparatively dull in tone they somewhat neutralize the brightness of the dyed wools with which they are combined. They also yield the characteristic tone of the mixture shade produced.

Wool is more suitable for tinting and adding freshness to the colour quality of the *mèlange* than dyed shoddy and mungo. The latter are deficient in purity of hue as compared with coloured new wool. On this ground, in producing such mixtures in low-class materials, brighter and richer tones—those intended to impart bloom, and depth of shade—should consist of wool fibre, that is, either fleece wool, noils, or pulled worsted waste. Moreover, for shoddy blends, of a Cheviot description, wool should, as a rule, be employed for this purpose, unless Crossbred noils or combed laps of a good natural colour are available. As a rule the dyed wool ingredient enhances the tone of the blend, and also the handle and appearance of the finished cloth,

to a fuller degree than dyed waste products from the worsted industry, though these may be well selected.

It will be seen that, in Blends I and II, though the proportions of the different "substitutes" are identical, the mixture tones vary, being neutral and brownish grey respectively. When the stocks of grey waste materials are considerable, a number of shades of a similar depth, but distinctive in hue, are producible by changing the bright or fancy colour ingredients. Another practice consists in making grey mungo or shoddy mixtures in medium and dark tones, and of increasing the quantities of the black or of the dark colour in the blends.

While, as pointed out, technical difficulties are experienced in obtaining brightness of tone in blending for coloured mixture shoddy yarns, it is feasible to expand the practice by adopting an ordered system of colour standardization and of colour admixture.

For grey shades, when a sufficient stock of re-manufactured material of an average grey tone and quality has been produced, definite quantities should be dyed black, brown, green, blue, olive, etc., and definite quantities "stripped" and dyed in similar colours but in medium tones. This results in the formation of a colour basis for acquiring two varieties of mixture shades—dark and medium in depth—with shoddy or mungo as the staple material in the blends. For this purpose a mathematical scale of proportions in the assortment of the different shades should be formulated.

With the two classes of colour units described, the materials are usable in some such schemes of percentages as follows:—

GRADED BLENDS. *Group I. Dark Shades.*

Blend A. 50 % of Mungo (blended grey shade)
40 % ,, ,, (black or dyed dark colour)
10 % ,, Fancy or bright colour (Botany laps)

Blend B.	60 % of Mungo (blended grey shade)	
	30 % „ „ (black or dyed dark colour)	
	10 % „ Fancy or bright colour (pulled Botany waste)	
Blend C.	70 % of Mungo (blended grey shade)	
	20 % „ „ (black or dyed dark colour)	
	10 % „ Fancy or bright colour (pulled Botany waste)	
Blend D.	80 % of Mungo (blended grey shade)	
	10 % „ „ (black or dyed dark colour)	
	10 % „ Fancy or bright colour (pulled Botany waste)	

GRADED BLENDS. *Group II. Medium Shades.*

Blend E.	50 % of Shoddy	(blended grey shade)
	40 % „ „	(dyed medium colour)
	5 % „ Colour	1, dyed Crossbred Noils
	5 % „ „	2, „ „ „
Blend F.	60 % „ Shoddy	(blended grey shade)
	30 % „ „	(dyed medium colour)
	5 % „ Colour	1, dyed Crossbred Noils
	5 % „ „	2, „ „ „
Blend G.	70 % „ Shoddy	(blended grey shade)
	20 % „ „	(dyed medium colour)
	5 % „ Colour	1, dyed Crossbred Noils
	5 % „ „	2, „ „ „
Blend H.	80 % „ Shoddy	(blended grey shade)
	10 % „ „	(dyed medium colour)
	5 % „ Colour	1, dyed Crossbred Noils
	5 % „ „	2, „ „ „

By using the sorts of dyed materials specified, and changing the colour of the wool fibre in each blend, serial ranges of mixture shades are formed. The mixtures, if toned with black, brown, blue, or an equivalent colour, in both dark and medium shades, are adapted to the manufacture of yarns and cloths correctly graduated in colour depth, though the tinting colour of the wool fibre may differ. Providing the fibrous ingredients coincide, the dark shades in Blends A to D are suitable for combination with the medium shades

in Blends E to H in making striped and checked goods.

In addition, this system of blending provides for the origination of patterns balanced in tone and composed of analogous and contrasting shades. Thus, in making dark-coloured styles of the first description, mixture shades resulting from Blends A, B, C and D may be applied to the ground of the cloth, and those from Blends E, F, G and H, composed of similar colour units, to the striped or checking features, or vice versa; and for dark or medium coloured styles of the second description, mixture shades may be selected in which the toning colours differ, such as brown and green and blue and olive, combining shades from Group I, or from Groups I and II, on the principle illustrated in the yarn arrangements appended—

ANALOGOUS MIXTURE-SHADE STYLES

A. *Patterns Dark in Tone.*

Example I.

Ground of the styles consisting of mixture shade A, with russett as the toning colour, striped or checked with mixture shade C, with light warm brown as the tinting colour.

Example II.

Ground of the styles consisting of mixture shade D, with green as the toning colour, striped or checked with mixture shade B, with pale green as the tinting colour.

B. *Patterns Medium in Tone.*

Example I.

Ground of the styles consisting of mixture shade H, with lavender and pale green as the tinting colour, striped or checked with mixture shade E, with deep blue and deep green as the toning colours.

Example II.

Ground of the styles consisting of mixture shade G, with tan and orange as the tinting colours, striped or checked with mixture shade E, with russett and olive brown as the toning colours.

Contrasting Mixture-shade Styles

C. *Patterns Dark in Tone.*

Example I.

Ground of the styles consisting of mixture shade A, with purple as the toning colour, striped or checked with mixture shade D, with yellow as the tinting colour.

Example II.

Ground of the styles consisting of mixture shade B, with deep green as the toning colour, striped or checked with mixture shade D, with red as the tinting colour.

D. *Pattern Medium in Tone.*

Example I.

Ground of the styles consisting of mixture shade E, with blue and orange as the toning colours, striped or checked with mixture shade G, with pale blue and light orange as the tinting colours.

Example II.

Ground of the styles consisting of mixture shade H, with heliotrope and fawn as the tinting colours, striped or checked with shade F, with purple and warm brown as the toning colour.

Four types of pattern construction are comprised in these examples, patterns A having a dark ground, striped with a medium shade, and patterns B a medium ground striped with a darker shade. Patterns C, if checked, would be in dark and medium tones with purple and yellow, and green and red as the contrasting hues, and patterns D would be in a lighter shade, with blue and orange and heliotrope and fawn as the contrasting hues in the mixture shades.

In blending, either in making yarns economical in cost or mixture-shade in colour, it is essential that the materials amalgamated should be thoroughly opened and admixed. Each class of material must be evenly distributed in the resultant yarn. To thus prepare the materials for the first process in thread production, that of scribbling and carding, they are therefore operated

upon in the teazer or run through the teazer and the fear-nought. The teazer, willow, or cockspur "willey"—Fig. 36—teazers, tears, breaks up, and separates the matted and entwined locks of filament, but should not damage the staple length of the material. The fear-nought, or tenter-hook machine—Fig. 37—completes the process of opening and re-blending of the fibres carried out in the "willey," by effecting a more searching disentanglement of the clustered fibres, and a fuller combination of the different materials.

The working parts of the teazer are enclosed, as observed in the general view of the machines in Figs. 6 and 36. These parts comprise a twelve-winged cylinder, over the upper portion of which are two or three small rollers or workers. The arms of the cylinder, and also the surface of the workers, are studded with strong metal teeth. The teazing width of the machine is 45 ins. to 48 ins. The swift, 39 ins. in diameter, runs at 400 to 450, and the workers, 14 ins. in diameter, at 25 to 30 revs. per min. On each arm of the cylinder there are 26 teeth, with 100 teeth on each worker, and 29 teeth in the fixed rail of the machine, placed behind the swift or cylinder.

The improved teazer has both a "feed" and "delivery" lattice table. The material to be treated is spread on the feed *A*—Fig. 36—which is intermittently driven. The table carries a prescribed quantity of the material to the rollers *F*, and is then automatically put and kept out of action until the lot of material supplied into the machine has been teazed. The spiked drum lashes the material from the grip of the feed rollers and whirls it round and round, when the entangled locks are met by the teeth of the slowly revolving workers and also by the teeth of the stationary rail.

Particles of hard fibre, dust and dirt, drop during the

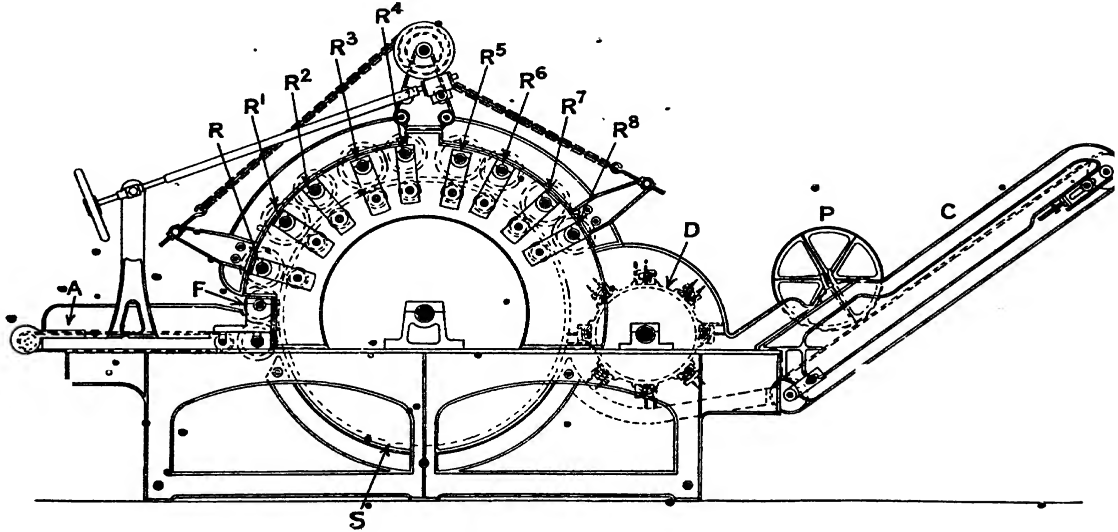


Fig. 38

SECTIONAL DRAWING OF THE FEARNOUGHT

process, on to the grid in the lower part of the frame-work. On the fixed time for the operation being elapsed, the delivery rollers, by means of the lattice, *B*, convey the teazed material into sheets, when these rollers are mechanically stopped and rollers *F* set in motion, and another lot of material is fed into the machine. The teazed material is also removed on the suction principle described in reference to Fig. 6. On the type of teazer made by Messrs. John Haigh & Sons, Ltd., and illustrated in Fig. 36, about 800 to 1,000 lbs. of material may be treated per hour.

In form of construction and in practical working, the Fearnought resembles a miniature carder, but with the rollers covered with tenter-hook teeth in place of the card or wire clothing applied to the rollers of the scribbler or carder. Its greater opening and mixing capacity, as compared with the teazer, is obvious from the three or four pairs of rollers R^1 to R^8—Figs. 37 and 38—mounted over the cylinder *S*, and the large number of teeth in the working parts of the machine. Thus, in a Fearnought—47¾ ins. wide—the different rollers contain the following number of teeth, and have the diameters and speeds indicated—

FEARNOUGHT, FIGS. 37 AND 38

Rollers and Letters.	*Dia. of Rollers Unclothed.*	*Dia. of Rollers Card Clothed.*	*Rev. per Minute.*	*Teeth in Roller.*	
F = 2 Feed Rollers	5"	6¼"	9½	2 Rollers	1,440
S = Swift	46¼"	47¾"	180	1 ,,	7,020
R = Angle Stripper	5½"	7½"	9½	1 ,,	560
R^1, R^3, R^5, R^7 = Four workers	6¾"	8¼"	9	4 ,,	4,320
R^2, R^4, R^6, R^8 = Four Strippers	5½"	7¼"	9	4 ,,	2,520
D = Fan	22"	25½"	810	1 ,,	540

Having a swift, 47¾ ins. wide, studded with 7,020 teeth, and making 180 revs. per min., the materials are repeatedly, in their passage through the machine, met by the teeth of the workers and the strippers

or rollers R^1 to R^8. The efficiency of the latter in opening the material is due partially to their reduced speeds as compared with the speed of the swift, and partly to the multiplicity of their teeth, namely, 1,080 in each worker, and 630 in each stripper.

The operation is performed by spreading the blended and teazed sorts on the table *A*, which passes them forward to the feed rollers *F*. Here the material is subjected to the tearing action of the teeth of roller *R* and of the swift *S*, by which it is carried to the first pair of rollers R^1 and R^2—Figs. 37 and 38. The teeth of the workers retain the more entangled locks which, in combination with the teeth of the strippers, they open, when the cylinder recovers the material. Unopened locks, escaping the action of the first worker and stripper, are dealt with by the second set of these rollers, and similarly unopened staples escaping the action of the second set are dealt with by the third and fourth workers and strippers respectively. A regular supply of separated filament is continually reaching the fan *D*, which this roller clears from the swift, keeping the teeth of the cylinder in a working condition, and passing the material on to the travelling lattice *C*, on which it is delivered from the machine under the perforated drum, *P*.

The preparation of the materials of different qualities for teazing, varies with the character and nature of the fibrous substances selected. When, for example, a large quantity of one class of filament is mixed with a smaller quantity of a second class of filament, blending may be done in two operations, namely, that of mixing a definite part of the larger with the smaller quantity, and then by re-mixing the result with the remainder of the first material. For instance, taking Blend A, page 121, it would be made by mixing, in the first place, the pulled yarn waste with a part of the pulled merinos; second, this mixture would be blended with the rest

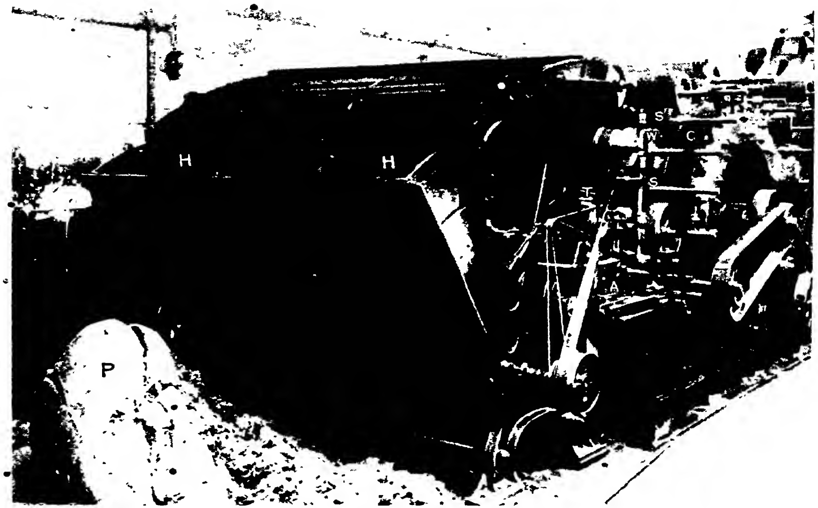


FIG. 39

FACTORY VIEW: SCRIBBLING MACHINERY

of the merinos; and third, the combined result would be blended with the cotton.

Layers or spreadings of each material, regulated according to their relative weights, are formed one over the other into a pile, and the oil or lubricant added as required. The piled material, designated a "mellowing" is afterwards cut into vertically in supplying it to the teazer. In blends of animal and vegetable fibres, the teazed wool substitute is first bedded with prepared cotton. This forms an "Angola mellowing." A spreading of this mellowing is next used as the basis of a new pile, which is made up of alternate spreadings of mungo or shoddy—previously run through the shake willey—and of the Angola blend.

The object to be attained is the complete opening of each class of material before piling, that is, the rendering of all sorts and qualities of staple assorted, in a favourable condition for becoming thoroughly admixed with each other in the teazer and fearnought.

CHAPTER VII

YARN PREPARATION

Condition of the Blended or Prepared Material—Processes in Yarn Manufacture—Card Clothing—Carding Machinery—Functions of the Swift, Workers, Strippers, Fancies and Doffers in Scribbling and Carding Machinery—Automatic or Hopper Scribbler Feed—Operation of Carding—Blamiere's Lap-former—Scotch or Overhead Carder Feed—Stages in Carding—Ring Doffers—Tape Condensers—Carding Output—Carded and Condensed Samples—Spinning on the Self-Actor—Changes effected in Spinning in the Condensed Sliver—Relative Counts of the Sliver and the Spun Yarn—The Yorkshire Carding Practice.

As a result of blending, and also of the operations of teazing, it is now understood that the wool substitutes, of different qualities, form a bulk material of a uniform character and of a given cost per pound. It is definable as a quantity of mixed staple in a fit condition for the processes of yarn manufacture.

The several sorts and classes of filament grouped together are so intermingled and amalgamated that, when fibre is separated from fibre and re-mixed, each material unit becomes accurately distributed, according to its proportionate weight, through and through the carded web, the condensed sliver, and the spun yarn. With, for example, the teazed lot composed of 70 parts of mungo, 20 parts of cotton, and 10 parts of pulled merinos, or of other materials in other quantities, each of the materials would be found to occur, in their specified ratios, in the web or ribbon of composite fibres delivered by the scribbler to the carder, and in the soft, unspun thread delivered by the condenser.

The blended fibrous product from the teazer is not, however, fully opened, nor can it be described as filament separated. On examination it is seen to contain pieces and clusters of material. In a blend of shoddy,

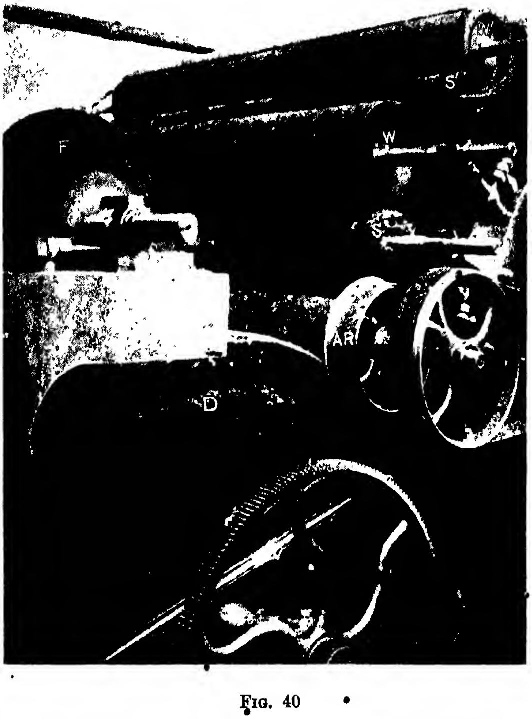


Fig. 40

SECTIONAL PART OF SCRIBBLER: FACTORY VIEW

yarn waste, and combed laps, the several wool substitutes are commingled in their relative proportions; but each class of fibre is, to a perceptible extent, unopened. Small lots of each material remain compacted. The fibres are not individually mixed and intercrossed. Shoddy, in such a blend, being derived from pulled rags, is in the more fibrous state, but particles of thread are visible in the yarn waste, and groups of fibres in the combed laps. By re-teazing, or by passing the blend through the fearnought, each material would be further disintegrated and the filaments of each would be better intermixed, but not to the degree, nor yet in the sense understood, as the fibres are associated with each other in the carded sliver.

Yarn manufacture, in the use of wool substitutes, is of a similar character and performed on similar machinery as yarn manufacture in the use of wool. It includes the processes of scribbling, carding, condensing and spinning. The two former are in reality a compound process, the "scribbler" being the first and the "carder" the second machine in which the work is done. Condensing takes place as the material is being stripped from the carder, and the "condenser" is therefore part of the carding machine.

All the rollers of these machines are covered with wire teeth or "card clothing." The points of the wire teeth—pricked in pairs into the leather or fillet foundation of the clothing as explained on page 98—are as hard as a needle at the point, but highly tempered below the bend, which adds to their working efficiency. The number or "counts" of the teeth, in a given width and length of clothing, varies with the nature and quality of the average material treated. It also varies, in practice, with the application of the "clothing" to the different rollers in the machine. *

* See pp. 111 to 116 in *Woollen and Worsted.*

The breast cylinder and the front rollers are covered with the coarser "counts"; and the fineness and multiplicity of the wire teeth increase from swift to swift, and from the scribbler to the carder. This gradual and systematic augmentation in the counts of the "clothing" is an important factor, for it renders carding more searching in character as the material advances from the earlier to the intermediate stages and from the intermediate to the final stages of the operation.

The cylinders or swifts convey the material from roller to roller, or from the feed to the doffing end of the machine. The workers and strippers—*W* and *S* Figs. 39, 40, 42 and 43—open and separate the material while the "fancy" roller brushes it on to the points of the cards of the swift after it has passed the last pair of workers, and the doffer strips the material from the cylinder. The function of the supplementary parts—the feed rollers, licker-in and angle strippers—will be explained in describing the process, by referring to the factory views in Figs. 39, 40 and 41.

The teazed material is delivered into the carding room in sheets, as seen at *P*, Fig. 39. Formerly this was spread on the feed sheet, *A*, of the scribbler by hand—a definite weight of material being evenly laid over a sectional part of the table. In modern practice, the material is placed, in large quantities at a time, in the hopper H of the automatic feeder. This is a complete piece of mechanism in itself, consisting of the hopper charged with the material, of a lattice sheet revolving vertically in the hopper, of a comb for clearing the pins of the lattice sheet, and of the tray or can *T*.

By wheel gearing, the intermittent action of the "feed" is regulated and controlled. When the "feed" is in operation, it deposits at intervals a fixed amount

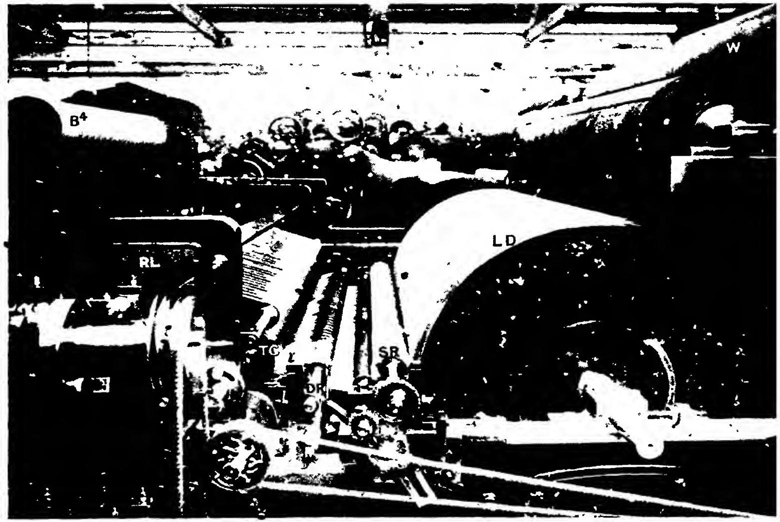


FIG. 41

FACTORY VIEW: CARDING AND CONDENSING MACHINERY

of material in the tray or receiver *T*, and, on the tray being full, it is automatically tilted or turned over, causing the material to fall on table *A*, Figs. 39 and 42, of the scribbler. In the meantime the hopper is stationary. On this principle the requisite quantity of fibre is successively supplied to the feed rollers of the machine, which pass the material to the licker-in —*L*, Fig. 42—and from this roller it is constantly being gathered up by the wire teeth of the cylinder.

The first cylinder or swift—*C*, Fig. 39—of the scribbler is termed the "breast." It carries the staples to the front pair of small rollers, or to the worker and stripper *W* and *S*. At this point the process of carding actually begins. The worker gleans up a portion of the material from the "breast" and separates and mixes the fibres in conjunction with its stripper. After being thus treated, the wire of the swift becomes effective in taking it from the rollers, and in conveying it to a subsequent worker, and stripper, where the process of fibre separation and crossing is repeated. On the breast cylinder, this routine occurs in three or four successive stages, as shown in the machine in Fig. 42.

The use of the "fancy" or "flyer," *E*, Fig. 40, consists in brushing up the fibre on to the surface of the wire clothing of the cylinder. For this purpose it is covered with longer and straighter wire teeth than the "card clothing" applied to other parts of the machine. The filament raised in this way can be readily removed from the cylinder by the doffer *D*, which revolves slowly and in an opposite direction to the swift. From the "breast" doffer the material is received by the angle stripper—*A R*, Fig. 40—the surface of which, it will be noticed, is covered with fibre, but not in a clustered and entangled condition as in the hopper feed, but in an open and separated state. From this roller the partially carded material is conveyed by the swift, C^1, Fig. 42, to

the workers and strippers as on the breast cylinder. Nepps of matted fibres will be observed on the "card clothing" of the rollers *W* and *S*, in Fig. 40. All such pieces of material, as the carding process continues, are divided and converted to a fleecy web, in which all the fibres are equally intermixed and intercrossed.

Scribbling is the first stage in carding, and the material is delivered from this machine, in the shoddy trade, on two systems; first, by means of the Blamiere's lap-former, and second by the Scotch or overhead mechanism. In either arrangement the scribbled material is automatically transferred on to the feed table of the carder, Fig. 43, which consists of two or three swifts, C^1 to C^3, with their respective sets of workers and strippers.

Carding is the second stage of fibrous web preparation. In one practice the prepared material, from the last cylinder of the carder, is removed by an upper and a lower doffer covered with rings of card clothing, with the rings of clothing in the upper doffer opposite the unclothed portions of the lower doffer, and vice versa. These rings of "clothing" divide the fleece of fibres into narrow strips which pass between pairs of rubber surfaces, and are formed by their action into thick threads or slivers.

In a second practice the "tape" condenser is used as illustrated in Fig. 41. Here the last doffer *LD* strips the material from the cylinder in the usual manner. From the doffer the prepared web passes between the rollers *SR*, to the dividing rollers and tape section of the machine. The tapes (metal or other bands) divide the continuous sheet of fibres into narrow ribbons, and carry them forward to the rubbing leathers *RL*. The latter oscillate from side to side, and also revolve, hence they rub or roll the narrow widths of material into soft threads, when they are wound on to the condenser

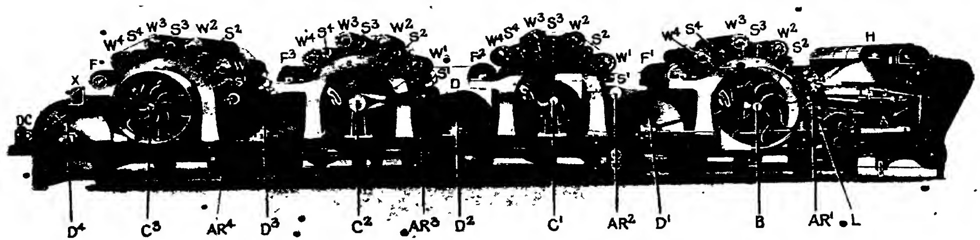


FIG. 42

FOUR-PART SCRIBBLER

(John Haigh & Sons, Ltd.)

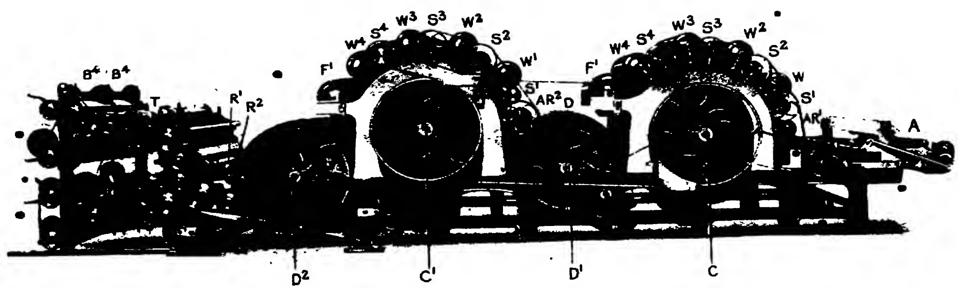


Fig. 43

TWO-PART CARDER AND TAPE CONDENSER

(John Haigh & Sons, Ltd.)

drums or bobbins, the upper one of four being shown at B^4.

The threads on these bobbins are known as slivers. A sample of the carded material, as taken from the last doffer of the carder, is shown in Fig. 44, and a sample of sliver prepared from this "carding" is shown at *A*, Fig. 45.

Carding output and efficiency depend upon three factors, as far as machine equipment is concerned—

1. The number of machines in a set, and the number of parts in the scribbler and carder.

2. The relative speeds of the cylinders, workers and doffers.

3. The character of the card clothing, that is, the counts of the wire and number of the wire teeth in a given area of the "clothing" covering each roller, and on the systematized closer setting of the workers and strippers to the surface of the cylinders from the first to the last cylinder in each machine.

The standard set of machinery—scribbler and carder—for mungo and shoddy work, as made by Messrs. John Haigh & Sons, Ltd., Huddersfield, is that illustrated in Figs. 42 and 43. It consists of the following—

SCRIBBLER (60 or 70 ins. wide)

H—Automatic Feed Apparatus

	Diameters.
Three Feed Rollers	$2\frac{1}{4}$ ins.
Taker-in in Roller	12 ins.
B—Breast Cylinder	54 ins.
C^1, C^2, and C^3—Cylinders or Swifts	54 ins.
W^1, W^2, W^3, and W^4—Workers	9 ins.
S^1, S^2, S^3, and S^4—Strippers	$4\frac{3}{4}$ or 5 ins., according to width of machine
AR^1, AR^2, AR^3, and AR^4—Angle Rollers	6 ins.
F^1, F^2, F^3, and F^4—Fancies	12 ins.
D^1, D^2, D^3, D^4—Doffers	40 ins.
X—Dick Roller	$4\frac{3}{4}$ or 5 ins., according to width of machine

CARDER (60 or 72 ins. wide)

Three Feed Rollers	$2\frac{1}{4}$ ins.
Taker-in Roller	4 or 6 ins., according to width of machine
C^1 and C^2—Cylinders or Swifts . .	54 ins.
W^1, W^2, W^3, and W^4—Workers . .	9 ins.
S^1, S^2, S^3, and S^4—Strippers . .	$4\frac{3}{4}$ or 5 ins., according to width of machine
AR^1 and AR^2—Angle Rollers . .	6 ins.
F^1 and F^2—Fancies	12 ins.
Fly Strippers	$2\frac{1}{2}$ ins.
D^1 and D^2—Doffers	40 ins.

TAPE CONDENSER (60 or 72 ins. wide)

R^1R^2, Fig. 43.—Stripping rollers, $3\frac{1}{2}$ and $2\frac{1}{2}$ ins. in diameter with the former card clothed. Dividing arrangement for making one sliver to each tape, and the condenser provided with eight pairs of rubber rollers and leathers, 9-by-9 and 6-by-6 inch centres, placed in four tiers and run in tandem order. Production: 160 good and 2 waste threads, collected by four sets of surface drums with 25 threads wound on to each bobbin or drum.

Technically, the scribbler in this set is said to consist of four parts, and the carder of three parts and condenser, implying that the former comprises breast cylinder and three swifts and the latter two swifts, and doffing and other mechanism for delivering the carded material in sliver form.

The weight of material placed on the feed sheet in a given time, and the length to which it is drafted or drawn out as it passes through the machines, determine the fineness or "counts" of the sliver produced; while the weight of the material placed on a fractional part of the feed sheet, and the speed at which it is carried forward by the swifts and delivered by the doffers, determine the carding output. The speeding up of the doffers increases the production; but beyond a certain standard, namely, that which results in the material being completely opened and intermixed by the action

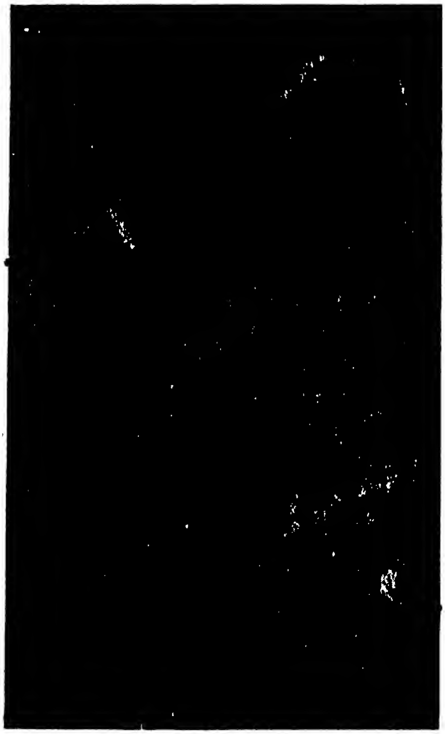


Fig. 44

SAMPLE OF CARDED WEB: SHODDY MATERIAL

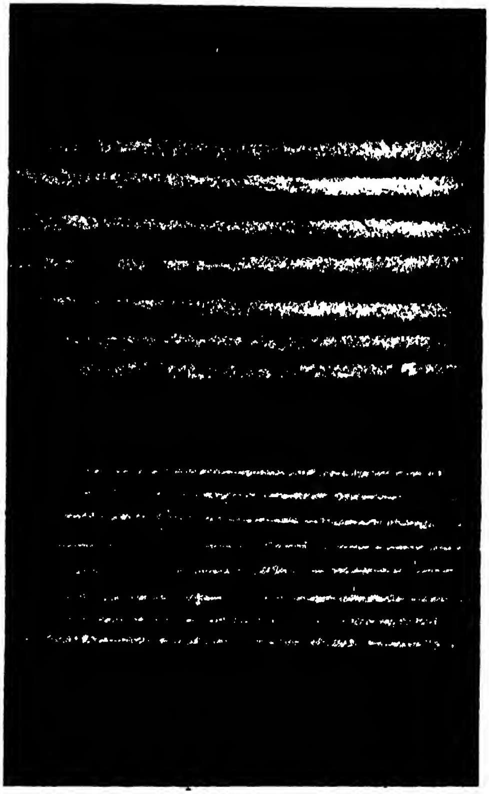


FIG. 45

A = CONDENSED SLIVERS: SHODDY MATERIAL
B = SPUN YARNS: SHODDY MATERIAL

of the swifts and the workers, speeding up becomes detrimental to good carding. In calculating the doffer speed, its revs. per min., and its diameter, are the two factors to consider. These fix its surface velocity, and this controls the length of the carded web obtained from a given weight of material automatically spread on the feed sheet of the machine. For blends of wool substitutes an average surface speed for the doffers is 60 ft. per min.

As examples in practical running, three sets of carding machines may be taken: (1) a set of two machines in which the scribbler is made up of a breast cylinder and two swifts, and the carder of two swifts; (2) a set of machines of five parts and a breast cylinder; and (3) a set of machines as shown in Figs. 42 and 43. The condenser in the first arrangement is of the double-doffer type, each doffer being 20 ins. in diameter, making 8¼ revs. per min., and yielding 40 threads. On this set, engaged on thick work, the production should average 68 lbs. per hour on 2 skeins yarn; 64 lbs. per hour on 2½ skeins yarn; and 60 lbs. per hour on 3 skeins yarn.

In regard to the second set, on 5 to 10 skeins work, a production of about 54 lbs. per hour should result. In this case the swifts are 54 ins. and the doffers 40 ins. in diameter. The surface speed of the swifts is 1,000 ft. per min., and that of the doffers 60 ft. per min. On the third set—Figs 42 and 43—100 lbs. per hour is attainable with the machines 72 ins. wide, and with the employment of a four-bobbin tape condenser.

The class of material dealt with in carding is a necessary feature to be taken into account when estimating output. Some blends of material involve more carding than others. If these, for example, should be composed of garnetted waste, pulled stockings, or carbonized shoddy, a maximum output is possible, because such

materials are, before carding, in an open, free condition, and also freely intermixed. On the other hand, should the blends consist of mungo and cotton, or of materials varying in filament length and fineness, they require a greater amount of carding, and to force such blends too expeditiously through the machinery produces unsatisfactory work. An adequate preparation of the materials on the teazer and fearnought contributes to economy in carding. This preparatory opening and mixing, when properly done, means a material product in a condition that augments carding output.

As previously stated, the threads on the condenser bobbins—B^4, Fig. 41—are described as "slivers" or condensed "slubbings." The effects of the scribbling and carding routine are evident in the material samples reproduced to scale in Figs. 44 and 45. Both these result from the treatment of shoddy derived from pulling khaki rags. The sample in Fig. 44 was taken from the last doffer of the carder or roller *LD*, in Fig. 41, and the sample at *A*, Fig. 45, from the same machine between the rubbing leathers—R^4—and sliver bobbins—B^4.

The condensed slivers are made into yarn by spinning on the mule or self-actor, a factory view of which is given in Fig. 46. The condenser bobbins, *E*, are fixed in the stationary frame of the machine, and the slivers are drawn from them by the delivery rollers *R*. These rollers, and the carriage, *C*, have an intermittent movement, and are controlled by the headstock of the self-actor.*

Spinning is done in four periods, following each other consecutively. At the commencement of the first period, the carriage is in a position close to the frame, and as it begins to recede the slivers, during delivery by rollers *R*, are held by the faller wire *F* in a line with the tips of the spindles on which the bobbins are placed.

* See Chapter III in *Woollen and Worsted* by the same Author.

Fig. 46

SPINNING DEPARTMENT: FACTORY VIEW

Hence, in the process, twist may be inserted into the slivers by the spindles without their being wound on to the bobbins. In the second period, the rollers *R* are automatically stopped by the control mechanism in the headstock, and the carriage continues to recede

FIG. 47

MICROSCOPIC VIEW OF CONDENSED SLIVER (MUNGO BLEND)

(First period of Spinning)

and the spindles to revolve, inserting additional twist into the threads and also drafting or elongating them. In the third period, when the carriage has reached the end of its traverse, and with the rollers *R* also inactive, the final degree of twist is given to the yarn. In the fourth or last period, that of winding the spun thread on to the bobbins, the faller wire *F* lowers the threads

into a correct position for winding. Simultaneously the faller F^1 comes into action for evening the tension on the threads as they pass on to the bobbins, and for forming correctly-shaped cops.

The changes, effected in the sliver structure, in these periods of spinning are illustrated in the microscopic

FIG. 48

SECOND PERIOD OF SPINNING (MUNGO YARN)

views in Figs. 47 to 50. The first is suggestive of the filament arrangement in the sliver—composed of mungo—after the first period, and when the full length of sliver has been delivered by rollers R—Fig. 46—and some twine imparted, namely, such as to render the slivers sufficiently tensile as to sustain drafting or attenuation without breakage. It will be seen that the fibres have assumed a wrapped or entwined order.

The second specimen—Fig. 48—is from a length of the same sliver when drafted and reduced in thickness, and after the insertion of additional twine. It is now a partially spun yarn, the fibres being loosely twisted round each other, the yarn being soft and loose in structure, though obviously of a more compact character

FIG. 49

THIRD PERIOD OF SPINNING (MUNGO YARN)

than the sliver-thread resulting from the first process.

Figs. 49 and 50 illustrate the effects of different degrees of twine after the third period. Specimen 49 is typical of the result on the completion of drafting and spinning; and specimen 50 of the result when the final twist has been given to the yarn, preparing it for winding on to the cop.

The three material resultants of carding, condensing, and spinning are also illustrated in Fig. 44 and in *A* and *B*, Fig. 45. In the carded specimen the completeness of the filament admixture and of filament crossing are observed in the filmy web of fibre produced. If microscopically examined, the material in this condition would be found to be consistent in fibre composition and

FIG. 50

FOURTH PERIOD OF SPINNING (MUNGO YARN)

assortment. Any irregularities in these features would be attended by production of a sliver uneven in thickness.

That the slivers—*A*, Fig. 45—should be regular in structure and in diameter is due to the correctness with which the carding has been done. The spun

yarns—*B*, Fig. 45—do not appear to show the same evenness of diameter as the slivers from which they have been derived. But it should be observed that, in the spinning of low qualities of material, in which the fibres differ greatly in length, however perfectly the work of carding and condensing is carried out, the difference in the behaviour of the shorter and of the longer fibres may be a cause of inequalities in the yarn surface.

The condensed sliver length, relative to the spun yarn length, is modified with the counts of the yarn produced, and also with the average fineness and length of the fibres of which the sliver is formed.

Investigation and experiment demonstrate that these two lengths need to be adjusted with the character of the thread required. If this should be "soft" spun, then the drafting should be accordingly reduced, in which case the condensed and the spun lengths would more closely approximate each other. If the yarn intended should be fine in counts and "hard" spun, the amount of the draft would be augmented, which means a thicker sliver in relation to the size of the spun yarn. But, in addition to these features, there is the controlling consideration of the material quality. The shortness of the fibre in mungo contracts the drafting range. On the other hand, in materials of a longer staple—such as shoddy obtained from stockings, etc., and pulled crossbred yarn waste—the filament length provides for a fuller degree of drafting.

The condensed slivers are usually prepared one-third thicker in "counts" than the spun yarn; but experiment and practice, in the carding and spinning of different classes of material, are the true guides to follow.

What will be apparent to the technical reader, is the

complexity of the machinery employed in shoddy and mungo yarn making. This machinery is of English origin, design and construction. On the measure of the practical science exercised in the setting and running of the machines, the success of the whole system of manufacture depends.

CHAPTER VIII

LOTH MANUFACTURE

Departments of Cloth Manufacture—Productive routine in Woollen, Shoddy and Worsted Cloth Manufacture—Factory Direction and Control—Field for Practical Work—Weaving—Types of Loom employed—Loom Output—Varieties of Shoddy and Mungo Cloths—Practices in Loom or Cloth Setting and Looming—Union Fabrics—Tweeds—Pilots—Friezes—Napps—Meltons—Blankets—Rugs—Face Cloths—Beavers—Cloth Finishing in the Shoddy Industry.

CLOTH Manufacture is divisible into three departments—Spinning, Weaving and Finishing. In the woollen industry the work of each department is performed in the same mill, or in mills under one administrative control. In the worsted and cotton industries, Yarn Preparation, Piece Weaving, and Fabric Dyeing and Finishing, are treated as separate branches of manufacture, and carried out in special factories, or in works under independent direction and management.

The woollen producer, whether concerned in the use of fleece wool, wool substitutes or both, deals with the whole routine of manufacture from the fibrous material to the finished and marketable goods. He requires, as a consequence, to be conversant with the nature, properties and applications of the different varieties of material; and, in the shoddy trade, with the yielding quality and value of the rags from which the reclaimed wool employed is derived. Further, he is called upon to organize the processes and operations associated with the conversion of the raw material into yarn, the yarn into cloth, and the cloth into an article of commerce.

The task of the worsted manufacturer is more centralized in character. It is mainly confined to piece

production, including the selection and purchase of yarns of the correct structure for making the classes of fabrics adapted to the trading requirements.

To briefly compare the systems of Worsted, Woollen, and Wool-Substitute Manufacture—custom and practice impel the producer, in the first system, to acquire the yarns from the spinner, obtaining those of a Botany, Crossbred, Angola or Woollen variety, according to the make and class of the goods in view. This implies that the worsted producer superintends and directs the weaving department, and that he is responsible for the origination of special varieties of cloth. The pieces, when woven, pass out of his hands for dyeing and finishing.

In the second system, the producer selects the wools applicable to his branch of the trade. These he sorts and blends, and cards and spins in making a definite description of yarn as to fibre composition, counts, degree of twine, or mixture shade. If the material ingredients are unsuitable for the development of the types of cloth intended, faulty piece production may result though the manufacturing procedure may be sound. It is therefore essential that correct yarns should be prepared. They form the basis of success in obtaining a saleable cloth, for the pieces are treated, in the finishing routine, in regard to the properties of the wool fibre used, and the type of yarn spun.

The sectional branches of blending, carding, spinning, weaving and finishing are interdependent. It follows that the two latter may be efficient, but should an error or discrepancy occur in the three former, or should the machinery equipment and process routine in yarn making be inaccurately planned and directed, the marketing of the woven goods is likely to be done at a discount.

Similar conditions obtain in the manufacture of

cloths made of wool-substitutes as in the manufacture of goods made of fleece wool. The producer's work, however, starts with the rags. Should these be injudiciously chosen, the fibrous materials obtained from them will be more or less deficient in quality for the kind of yarn and cloth required. Provided the rag product is satisfactory, the pulling and blending of the materials for getting a yarn of the right fibrous substance and density, and a cloth of a suitable nature and value, entails skilled practice in carding and spinning, combined with competent mill organization. Defects in one stage or another of manufacture develop crucial problems in cloth construction, for the character of the woven and finished fabric is determined by the character of the yarns, and the cost of the yarn controls the selling price of the cloth.

The several sections of a modern shoddy factory are under the direction of the technically trained expert. To advantageously utilize the flexble means which the industry offers in productive capacity and range, it is regarded as vital that the thinker should be actively associated with the practitioner. This combination ensures standardized results, and the development of new avenues of manufacturing activity. Invention and discovery are thus fostered and exploited under conditions favourable to trading strength and growth.

In the diversity of raw materials usable, and in the changes feasible in yarn and fabric construction, the shoddy manufacturer discovers an ample field for practical experiment in new cloth origination. Thus, by focusing specialized knowledge on the selection and assortment of the raw materials, and on the scheme of manufacturing operations, he succeeds, in the first place, in effecting improvements and economies in yarn and cloth production; and, in the second place,

in modifying, as trade demands, the make, style and finish of the goods.

When thus conceived, woollen and union cloth manufacturing, with shoddy and "waste" fibre as the raw materials, has its practical, technical, and originative phases. The practical phase concerns amplified systems of work for securing intrinsic value and newness in the commercial result; the technical phase concerns problem investigation and solution; and the originative phase concerns inventive effort as evinced in improved machinery and in augmented economy and efficiency in the processes of manufacture

Weaving is the department in which the spun yarn is used in making the fabric. It comprises, in addition to piece production, the operations of warping, beaming, healding and sleying.

In warping, the required number of cops or bobbins of yarn are mounted in a creel. These are combined in forming a chain or warp of a specified number and length of threads for producing a piece of a definite width and length. The warps are frequently made in sections on what is termed the sectional warping machine. In this machine the ends from the cops pass between the splits of a coarse reed, through a sizing trough containing the sizing solution, over a number of drying cylinders, and through a second reed on to the sectional beam or "cheese." At the beginning and completion of each "cheese" a lease is taken, crossing the threads in alternate order. Bands or cords are inserted into the leases to keep the ends or threads in the positions, assigned to them in the warping process, in the looming and healding operations. With the "cheeses" 4½ ins. in width, and the warp 72 ins. wide, 16 such "cheeses" would be placed on the shaft of the beaming frame. From the "cheeses" thus placed the yarns run through a raddle or sley in being drawn from end to end of the

frame, and as they are wound on to the chain beam of the loom. Warping on the mill or large creel, revolving in a vertical or in a horizontal position, is also practised.

Healding follows, and consists in threading the yarns into the healds of the shafts or heddles. The "reacher-in" hands the threads, one by one from the lease, to the "drawer-in," who passes his hook through the healds in the correct sequence for this purpose. After healding, the warp is sleyed by entering the threads in sets of two, three, four, etc., into the dents of the reed. The prepared, healded, and sleyed warp is now fixed in the loom, when the shafts are secured to the shedding mechanism, and the ends of the warp fastened to the wrapper of the piece beam.

Weaving, in the low-woollen trade, is done on three types of looms—the Tappet, the Dobby, and the Jacquard, terms denoting different principles of shedding. Tappet shedding is the simpler type and is adopted in making plain and twilled goods. Dobby shedding is applicable to either plain or fancy fabrics, and Jacquard or harness shedding to the production of figured rugs and various grades of tapestries and carpets.

Looms of an improved construction are employed in shoddy factories, namely, those with positive warp let-off and piece take-up motions; with several shuttle boxes on each side of the going-part; with weft-stop mechanism; and, in some instances, with automatic weft-supply motions.

Actual weaving consists of (1) shedding or dividing the warp yarns, by lifting and lowering the heald shafts in a prescribed order; (2) picking or shuttling; (3) beating-up or forcing the picks or shots of weft into position by the movement of the going-part; (4) letting-off of the warp or chain; and (5) taking-up of the piece as it is woven, or as pick by pick is inserted into the warp.

In the factory the looms are arranged in aisles. They receive motion from a line shaft, either motor or belt driven. The number of looms, and the speed at which they run, determine the productive capacity of the mill, or the number of looms used controls the mechanical equipment of the departments both preceding and following weaving.

The length of the cloth woven necessarily varies with the picks per inch in the goods. Assuming the speed to be 90 picks per min. (a fair average), and the picks per inch on three types of loom-mounting to be 20, 30 and 40 respectively, with an allowance of 10 per cent for stoppages—due chiefly to the re-filling of the shuttles and the taking-up and repairing of broken warp threads—the yard production per week of 48 hrs. would be—

Loom speed.	*Picks per inch in goods.*	*Production in 48 hours.*
90 picks per inch	20	324 yards
	30	216 „
	40	162 „

Reducing the operative week to 40 hrs., with an installation of 1,000 looms, running at the speed named and inserting 20 picks per inch in the cloth, would be equivalent to a diminution in output of 54,000 yds. This one factor is significant of the loss which the contraction of the working week entails in productive results in the textile industries.

Both felted and woven goods are made of shoddy, mungo and pulled waste. The loom manufactures form, however, the bulk of the trade, and comprise the following Group Classes of cloths—

Group I. Cloths in which both the Warp and Weft Yarn are of a Shoddy description.

Group II. Cloths having a Cotton Warp crossed with a Mungo or Shoddy Weft Yarn.

Group III. Cloths having a Worsted Warp crossed with a Cotton Weft (face intersecting yarn), and Mungo or Shoddy Weft (back intersecting yarn).

Group IV. Cloths having a Cotton Warp crossed with a Worsted Face Yarn, and a Mungo or Shoddy Backing Yarn.

Group V. Cloths compound in structure, made of various counts and qualities of Yarn.

The manufactures in Groups I and II represent two schemes of fabric construction. Fig. 51, for example,

FIG. 51

SHODDY TWEED

is a typical tweed made of shoddy warp and weft yarn, and illustrative of the cloths in Group I; and Fig. 52 is a typical checked union rug with mungo yarn for weft and cotton yarn for warp, and illustrative of the cloths in Group II. These examples suggest, first, the common principle of weaving, that of using both the warp and weft yarns in making the twilled features of the cloth, and second, the compound principle of weaving in which the weft yarns build both surfaces of the fabric, and conceal the warp or cotton yarns.

The respective cloths also demonstrate different practices in loom setting and finishing. In the suiting texture—Fig. 51—the twilled lines are developed in both warp and weft yarns. As the materials are of a shoddy variety they necessitate the pieces being well milled to give firmness and wearing strength to the fabric. This milling practice—which obtains in a greater or lesses degree in all classes of shoddy and mungo manufactures—implies that the pieces are wide set in the reed, and comparatively loose woven. In Cheviot tweeds, of this weight per yard, the pieces would be woven narrower in the reed than shoddy pieces for the same finished width, and the cloths would only require a minimum amount of finishing. Cheviots are, as a result, clear, bright and fresh in colour, and also full in the handle, whereas shoddy productions are duller in tone and harder in the feel. These differences are partly attributable to the respective qualities of wool and shoddy, but they also arise from the increased amount of felting necessary in the shoddy as compared with the Cheviot manufacture.

The union type of fabrics—Fig. 52, Group II—is producible in both shoddy and woollen yarns. The object in their construction is a cheap class of goods having a similar nature, and also application as cloths made of warp and weft yarns consisting of new wool fibre. To secure these features the two-ply weft structure of cloth is used. This provides for the weft yarn making each surface of the fabric, so that the cotton warp threads pass between the two layers of weft yarn, which they regularly and evenly bind together. Such layers of yarn, in producing pattern details, alternate in position, or from one side of the cloth to the other. Again, the pieces are heavily felted and also raised on both sides, covering the face of the cloths with fibre.

The commercial varieties of fabrics, included in the several Group Classes, are—

In Group I.—Tweeds, Pilots, Friezes, Napps, Meltons, Rugs, and Blankets.
In Group II.—Face-Costume Cloths, Beavers, Raised-pile Fabrics, Figured Rugs and Decorative Cloths.
In Group III.—Union Worsteds, Coatings and Suitings.
In Group IV.—Union Worsteds, Dress and Mantle Cloths.
In Group V.—Union Compound-make Cloths, Reversibles and Lined Overcoatings.

The trading range of the industry is suggested by the commercial varieties of cloth produced, which will be considered under the Group Classes of manufacture defined—

GROUP I. *Shoddy Tweeds* average from 16 to 24 or 26 ozs. per yard. They are woven in solid and in mixture-shade yarns. Cheviot tweed characteristics are acquired, in such cloths, by using strong-fibred shoddies to which, in the better grade productions, a percentage of fleece wool may be added in preparing the blend. This practice results in the goods possessing some of the tinted and wearing qualities of the Scotch or Irish tweed.

Pilots are overcoating cloths made in solid shades and piece-dyed, heavily milled and fibrous finished, and cassimere twill in construction.

Friezes are thick makes of cloth, also twill woven, wide set in the loom, e.g. 90 or more ins. for 54 ins. finished. The wool substitute used is of the shoddy class, and spun to yarns of 3 to 8 yds. per dram. The pieces are excessively felted in both width and length, and this develops the rough filament surface, or the "frieze" quality.

Napps form a special variety of overcoating cloth made in both mungo and shoddy materials. Mat weaves of an open structure, as well as twilled weaves, are employed. The pieces are set 74 ins. to 86 ins. in

the reed, milled to 58 ins. or 59 ins., washed off, dyed, raised, tentered and napped. In the last operation the raised fibre is rubbed into a curl or napp condition.

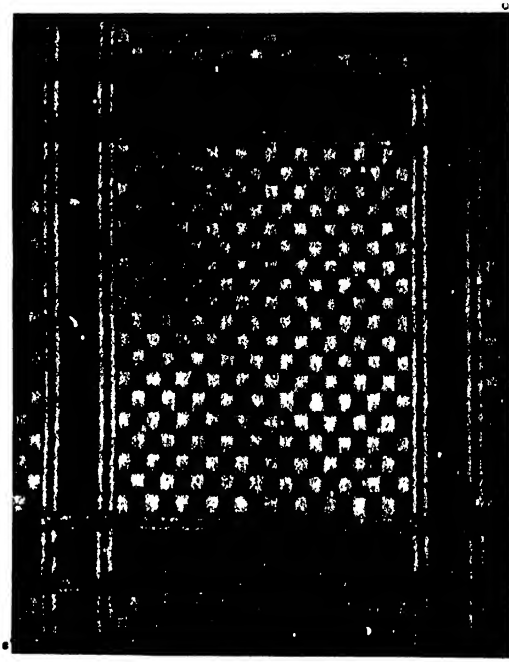


FIG. 52
UNION CHECKED FABRIC
(Cotton Warp, Mungo Weft)

Meltons are hard, firm-finished goods, plain or broken twill in the make. The substantial handle of the fabrics results from close weaving and heavy felting. As an example, one build of cloth, produced in 13 skeins warp yarns, set in a 12's reed 2's, and crossed with

11½ skeins weft, with 28 picks per inch, is weavable in the $\frac{2}{2}$ twill, cutting 2's in the weft. Width in the reed 92 ins., and finished as follows—

Milled to 57½ ins. and 20 per cent. in length, washed off, tentered, cut, dyed, re-tentered, brushed and steamed, re-cut, re-brushed and steamed, hot-pressed, re-steamed, cold-pressed and steamed.

Blankets are made of both the shorter and longer descriptions of substitutes, that is in materials suited to the type of pile required in the goods. They are plain woven, well felted, and raised damp on both sides.

Rugs include, in the low-grade manufactures, "horse rugs"; and, in the better manufactures, travelling rugs, woven in fancy shades, and in checked patterns, as in Fig. 52.

GROUP II. *Face Costume Cloths.* These are a thin variety of plain fabric with cotton warp and mungo weft. The cotton threads are concealed by the weft yarn, being thicker in counts than the warp yarn, and by having an excess of picks as compared with threads per inch in the weaving of the pieces. In milling, the filament quality of the mungo yarn develops softness and fullness of cloth. The fibrous surface is raised with the pieces in a damp condition, and this produces the "dressed," "pile" or "face" finish characterizing these cloths.

Beavers. These cloths are also face-finished, but of a heavy structure, from 22 to 40 ozs. per yard. They are two-ply in weft structure, the weave being a double-weft swansdown, or a double-weft sateen. The finishing routine of these goods is varied and complex in character. The particulars of manufacture and finishing for a 22 ozs. cloth are as follows—

Warp. **2/30's black Cotton, 12's reed 4's, 90 ins. wide in the loom.**

Weft. 15 skeins Mungo, 72 picks per inch. Weave, 5-shaft sateen : weft reversible.

Finishing Routine. Knot and mend, scour with alkali, 8° Twaddle, mill to 58 ins., raise four times, tenter, dry-beat, cut, hot-press, boil, 170° F., wash off (repeating these two processes three times). Re-tenter, re-dry beat, re-cut, brush and steam, re-press hot, re-steam and cold-press.

It will be observed that prior to dyeing, the piece passes through the complete series of finishing processes.

Raised-pile Fabrics. These cloths have what is termed a velvet pile surface. If made of yarns consisting of mohair or lustre laps, or pulled waste from mohair and lustre yarns, the pile is of a bright character, and the goods are sometimes called "mohairs." The warp yarn is cotton and the fabrics may be single or two-ply in the weft; if two-ply, reversible goods are produced which are finished on both sides.

Figured Rugs and Decorative Cloths. The weaving of these goods is done in harness looms, using both mungo and shoddy yarns. The milling and finishing develop a velvet pile on the face and back of the rugs. The decorative cloths are ordinary as well as pile finished, but, like the rugs, are two or three-fold in the weft, developing the figured effects in the weft yarn and in several shades. Certain varieties of union carpets, with a cotton warp and wool-substitute weft, are also produced.

The cloths in Groups III, IV and V are manufactured of different yarn units such as worsted, cotton and shoddy, and also cotton and union twist threads. Fabric weight and pattern type are, however, obtained by the method of using the yarns made of re-used fibre or wool substitutes. As a rule such yarns yield from one-half to two-thirds of the fibrous substance of the piece. The cloths are constructed on the compound warp and weft principles of weaving. Fabrics of the

first category are two-fold in the weft and single in the warp, and those of the second category two or three-fold in both warp and weft.

The weft-compound cloths are of two varieties; (1) those in which the *warp* yarns are *worsted*, and the *weft* yarns *cotton* and *shoddy*; and (2) those in which the *warp* yarns are *cotton*, and the *weft* yarns *worsted* and *shoddy* or *mungo*. *Warp-face* weaves—e.g. prunelle twill, whipcord and Venetian twills—are employed in the manufacture of the former, and *weft-face* weaves—e.g. $\frac{3}{1}$ twill, derivatives of the sateens, and small diagonals and other plans in which the effects are weft-formed—in the manufacture of the latter.

The following are data for the construction of a backed-prunelle union worsted coating—

UNION WORSTED (*Worsted Warp, Shoddy, and Cotton Wefts*).

Warp; 2/48's Worsted
22's reed 4's
64 ins. to 66 ins. in the reed.
Weft; 1 pick of 2/40's Cotton
1 pick of 8 skeins Mungo or Shoddy
84 picks per inch.
Weave; Prunelle twill face, 9-shaft sateen back, arranged 1 pick face, 1 pick back.

In this build of texture, neither the cotton nor the shoddy weft shows on the face. These yarns are concealed by the "full" setting in the warp, and also by the weave plan. The cotton weft stitches with the worsted ends for the development of the twill, but it is hid by the warp threads; and the shoddy weft yarns interlace 8-and-1 on the underside of the cloth. As a consequence the shoddy yarns are useful in making a sateen back without appearing on the face of the texture. The practice applied in finishing is contributory to these results. It is formulated to bring out

the worsted twill, and to develop a fibrous quality on the back of the cloth, or on the sateen surface consisting of the shoddy yarn. With this object in view, in the milling, the pieces are subjected to compression and shrinkage in the direction of the weft, but not in the direction of the warp, inducing width but not length contraction. After dyeing, the goods are raised in a moist condition on the reverse side for getting up a napp of fibre, which covers the structure of the shoddy yarns in the finished cloth. The face side is subsequently brushed and cut clear, when the pieces are pressed, steamed and cold-pressed.

In the second variety of worsted union, partially made of shoddy and cotton yarns, such weaving particulars as those illustrated below are applied—

UNION WORSTED (*Cotton Warp, Worsted Face-Weft, and Shoddy Backing-Weft*).

Warp; 2/40's Cotton
16's reed 3's
68 to 72 ins. in the reed.

Weft; 1 pick of 2/30's Worsted
1 pick of 10 skeins Mungo
84 picks per inch.

Weave; 12-shaft fancy twill equal to one warp and three weft in order of intersection, and backed with a 6-shaft twill or sateen equal to five weft and one warp in order of intersection.

This plan of construction conceals the cotton warp, and provides for the face effects being woven in worsted yarn, and for the back of the cloth being woven in mungo or shoddy yarn. Some milling is necessary, as in the warp-face union. This imparts fullness of handle to the cloth by rendering the backing yarns in a condition favourable to raising.

The compound warp and weft productions—Group V—enable different classes of reversibles to be manufactured, such as those of a lining description. The

scheme of weaving also admits of the use of cotton-centre yarns, which may be inserted into the cloths as a special warp or weft. If applied in the warp and also in the weft, such cotton yarns produce a thin texture between the face and backing yarns of the compound fabric.

Fig. 53 may be taken as suggesting the principles of fabric construction utilised. It is a mungo-and-cotton yarn lined overcoating cloth, with a small pattern on the

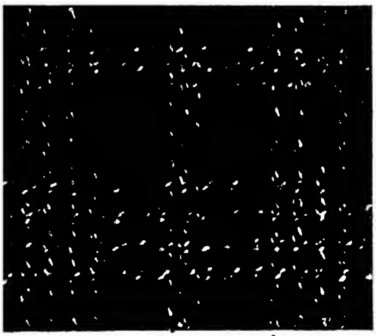


Fig. 53

LINED OVERCOATING

(Mungo and Cotton-Twist Yarns)

face and a checked pattern on the back. The weave is double-cassimere, with the addition of centre-warp threads—cotton—which form an appreciable proportion of the weight of the finished piece. These centre threads, being depressed on the face and lifted on the backing picks in the weaving of the fabric, occupy an intermediate and invisible position in the cloth structure. In this typical example, for which the underside or

lining pattern is shown in the specimen, the yarns are arranged in the warp and weft thus—

Warp; 1 thread face
1 „ centre
1 „ backing
1 „ face, and
1 „ backing.
Weft; 1 pick face, and
1 pick backing.

The full looming particulars for the manufacture of the cloth are—

			lbs.	ozs.
Face Warp.				
14 skeins Black Mungo	4 3	10	17	1
2/28 skeins Twist	2 1	ends	7	14
Backing Warp.				
14 skeins Black Mungo	2 2 2 12 1 1 12 2 2 2 28 1 1 30	122	19	9
2/28 skeins Twist	2 2 2 2 1 2 1 2 2 2 2 1 2 1	ends	4	13
Centre Warp.				
2/26's Black Cotton			4	0
Face Weft.				
14 skeins Black Mungo			21	12
Backing Weft.				
14 skeins Black Mungo	2 2 2 12 1 1 12 2 2 2 30 1 1 30	124	17	8
2/28 skeins Twist	2 2 2 2 1 2 1 2 2 2 2 1 2 1	ends	4	3
		Greasy weight	96	12
		16% Loss in Finishing	15	7
		Finished Weight	81	5

14½ reed 4's.
65 ins. in the reed.
44 picks per inch.
58 yards of warp = 54½ yards woven and 50 yards finished.
Finished cloth = 65 to 66 threads and 48 picks per inch.
Approximate finished weight per yard, 56 ins. wide = 26·1 ozs.

The detail calculations are supplied, in this instance, for giving some idea of the relative percentages of the different yarns, and also for suggesting the basis on which the finished weight per yard of the cloth is arrived at from the weaving particulars.

From the systems of warping and wefting here practised, and also from the several fabric structures

which have been described in treating of the cloths, particularly in Groups III, IV and V, page 143, it is to be understood that the standard principles of woven design and of fabric building—with suitable changes in yarn counts, setting, and in finishing routine—are as fully identified with the production of goods made of wool substitutes as with the manufacture of goods made of fleece wool.

Cloth finishing is all-important in this branch of the woollen industry. It is a subject, however, which cannot be dealt with in this treatise (see *Finishing of Textile Fabrics*), but it should be observed that the intrinsic and selling merit of the cloths produced, is largely dependent on efficient practice in dyeing and finishing. On this account, in the up-to-date woollen factory, in which shoddy and mungo are used, the finishing plant is varied in organization and equipment; with the machinery designed and planned to afford every facility for adapting the milling, raising, lustreing, and other processes of work, to the classes of manufacture in vogue, whether Tweed, Saxony, Napped, Curled, Velvet-Pile, Melton or Dressed-Face in quality and character.

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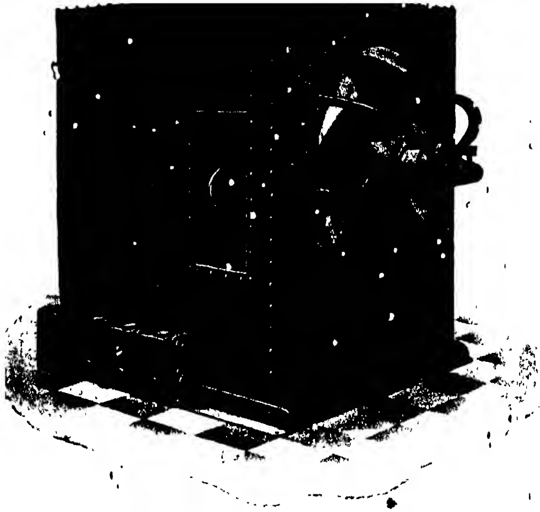

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